Cardell® MAX-12 DUO HD

Veterinary Vital Signs Monitor

User's Manual

MIDMARK®

For Veterinary Use Only

003-2423-00 Rev. E (4/3/13)

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SECTION 1 INTRODUCTION

1.1 General

Welcome to the Cardell® MAX-12 HD Multiparameter Monitor for use on small and large animals. It continuously monitors and displays the following physiological parameters: blood pressure, ECG, respiration, arterial blood oxygen saturation of arterial hemoglobin (SpO_2), carbon dioxide (CO_2), and temperature. Some versions include invasive BP and/or multigas monitoring. It converts the various physiological changes into data and calculates, analyzes the data, and then displays the data on the screen. When the monitored data exceed the preset limits, an alarm system activates and sends a signal to alert the staff's attention.

The Cardell MAX-12 HD Multiparameter Monitor uses internal battery power or AC power.

Before using the patient monitor, please read this manual thoroughly in order to use the monitor correctly and to ensure the monitor performs according to the specifications and in conformity with the safety standards.

This manual is an integral part of the product and describes its intended use. It should always be kept with the monitor. Observance of the manual is a prerequisite for proper product performance and correct operation and ensures patient and operator safety.

1.2 Product Support

1.2.1 Warranty

Please register your warranty, either using the post card included, or online if indicated. After unpacking the system, you may want to keep the packing materials for future return for service if necessary. The manufacturer is responsible for the safety, reliability, and performance of the monitor.

The warranty applies if the product is used according to the operator's manual instruction.

The warranty does not apply if the product:

- has been damaged from improper operation (misuse).
- has been damaged because of improper connection to other devices.
- has been damaged by accident.
- has been modified without written authorization of the Company.
- has had the serial number removed or defaced.

1.2.2 After-sale service

To obtain service or product support, please contact Midmark in Tampa, Florida at **800-643-6275** or visit the website at www.Midmark.com. Have the following information available:

- model and serial number of the equipment
- date of purchase and distributor name

1.3 Important Information

- The product is made under the ISO9001:2000 and ISO13485:2003 quality system.

- Manufacturer address: Midmark
  10008 N. Dale Mabry Hwy, Suite 110
  Tampa, FL 33618

- **Phone**: 800-643-6275 **Fax:** 813-264-6218

SECTION 2 SAFETY

2.1 Safety Notice

2.1.1 Intended Use

The Cardell® MAX-12 HD is used to provide continuous monitoring, display and recording of physiological parameters, such as: ECG, non-invasive blood pressure, SpO_2, CO_2, respiration, and temperature.

2.1.2 Application Environment

This device is for use by trained veterinary personnel in veterinary centers. The device is restricted to be used on one patient at a time.

2.1.3 Operator Requirements

Only veterinary personnel who have read the Operator's Manual should use this monitor.

2.1.4 Terminology

The terms danger, warning, and caution are used throughout this manual to point out hazards and to designate a degree or level of seriousness. Please familiarize yourself with their definitions and significance.

DANGER is defined as a source of potential injury to an animal.

WARNING indicates a potential hazard or unsafe practice which, if not avoided, could result in death or serious injury.

CAUTION indicates a potential hazard or unsafe practice which, if not avoided, could result in minor personal injury or product /property damage.

NOTE provides application tips or other useful information to assure that you get the most from your equipment.

2.1.5 Monitor Safety

The safety statements presented in this chapter refer to the equipment in general and in most cases, apply to all aspects of the monitor. There are additional safety statements in the parameter chapters that are specific to that monitored parameter.

The order in which safety statements are presented in no way implies order of importance.

There are no dangers that refer to the equipment in general. Specific "Danger" statements may be given in the respective sections of this manual.

2.2 Safety Requirements

WARNING

- The Cardell® MAX-12 HD is not intended to be used as an apnea monitor.
- Do not use it during MRI scans.
- Please do not rely on the alarm functions of the patient monitor. The alarm limits may have been improperly set or the alarm may have been disabled.
- Alarm functions of the patient monitor must be checked regularly.
- Before using the cables, please check the cable and connectors. If any damage is found, replace it immediately.
- Electro-surgery circuit must be connected properly to prevent burns or even death.
- When several devices are used on the same patient, leakage current may increase and lead to danger to the patient. Before using, please consult a professional to do a leakage current test and make sure the leakage current is within safety limits.
- When a defibrillator is used, make sure patient will not touch the ground,

metal or other conductor or device. During defibrillation, never touch the patient, table or the device.

- When electrosurgery unit is used, make sure the patient lead and cable are far away from the operating table to reduce the risk of burns caused by poor connection.
- Before using on another patient, make sure previous monitoring data is cleared.
- Before using the monitor, make sure it is in normal working condition.

CAUTION

- Use properly grounded power sockets and ensure adequate grounding. If there is any doubt about the grounding, please use battery operation.
- Check accessories on regular basis and discard damaged accessories properly.
- To ensure patient's safety and performance of the product, use only the manufacturer recommended accessories.
- Service parts must be in conformity with IEC 60601 standards. The system configuration of monitor must be in conformity with IEC 60601-1-1 medical electric standard, otherwise, it will reduce the safety of monitor.
- Even while not being used, the battery may also discharge. So check battery level every month.
- ECG cable socket is for connecting ECG lead wires only. Please do not connect it to any other signal source. Pay attention to the color label and marks of ECG lead wires.
- Please clean the monitor and accessories according to instructions. Always unplug the power cord before cleaning.
- EMC — The device is in conformity with the requirements of IEC 60601-1-2 and related EMC standards. But when electromagnetic power is extremely high, it may cause interference. Please ensure any device close to the monitor meets the related EMC requirements. Do not use cell phone or personal telecommunication devices next to the monitor.
- Unknown EMI may be caused by radio transmitter or TV. Please remove

the patient monitor or add shielding materials.

- INSTRUCTIONS FOR USE – For continued safe use of this equipment, it is necessary that the instructions are followed. However, instructions listed in this manual in no way supersede established medical practices concerning patient care.
- Loss of data — When the device accidentally loses data, please keep patient under close attention until the device returns to normal.
- Other devices connecting to the device should meet IEC standards (for example, data processing device should meet IEC 950 and medical device should meet IEC60601-1) and the whole system should meet the latest version of IEC60601-1-1 standards.
- Plastic bags and other packaging materials should be disposed of in accordance with related regulations.
- After the device or the accessories are at the end of their life cycle, please dispose of them according to local laws and regulations.

2.3 Safety Symbols

Note: Depending on the configuration of your monitor, it may or may not have the following labels:

BF applied part: Type F applied part meet the requirements of IEC60601-1 standards. Shock protection level is higher than Type B applied part.

Defibrillation protection Type CF applied part: Type F applied part, in conformity with IEC 60601-1 standards. Shock protection level higher than BF applied part.

Note: Please check accompanying documents

Fuse

Equipotentiality

Power ON/OFF(Press-Press)

~ AC

Protective Ground

2.4 Installation

2.4.1 Unpacking and Check

When you unpack monitor and accessories, check accessories according to the packing list. Check for any damage to the equipment or the external lead wires and accessories.

In case you have any other questions, please contact Midmark at 800-643-6275.

2.4.2 Environmental Requirements:

To ensure electric installation safety, the environment should be reasonably dust free, without corrosive or combustible gas, or extreme temperature or humidity.

Keep the monitor at least 2" from the wall to ensure good air ventilation behind it.

2.4.3 Power Supply Requirements

The Cardell® MAX-12 HD Multiparameter Monitor is a Class I device with internal power supply in conformity with IEC60601/EN60601 requirements. It can use AC power or its internal battery.

Connect AC Power

When using AC power, the MAX-12 HD may be turned on at any time. Before plugging it into the outlet, check outlet's power output with the

requirements of the device.

Once plugged in, power is indicated on the front panel by a yellow light. This shows the monitor is in standby condition and the battery is charging.

2.4.4 Combination Of Equipment

Both medical and non-medical equipment must comply with IEC60601-1-1 standard.

Warning: The use of many devices together can increase the leakage current, which may injure the patient and personnel.

2.4.5 Operation

Press and hold the power button until the monitor turns on. The system will start self-test, and then start the monitoring screen. If the power indicator on the front panel is green, it shows that the device is in normal working condition and can be used for vital sign monitoring.

SECTION 3 DEVICE DESCRIPTION

3.1 Front Panel

The front panel of MAX-12HD multi-parameter patient monitor is as shown in Fig. 3-1:

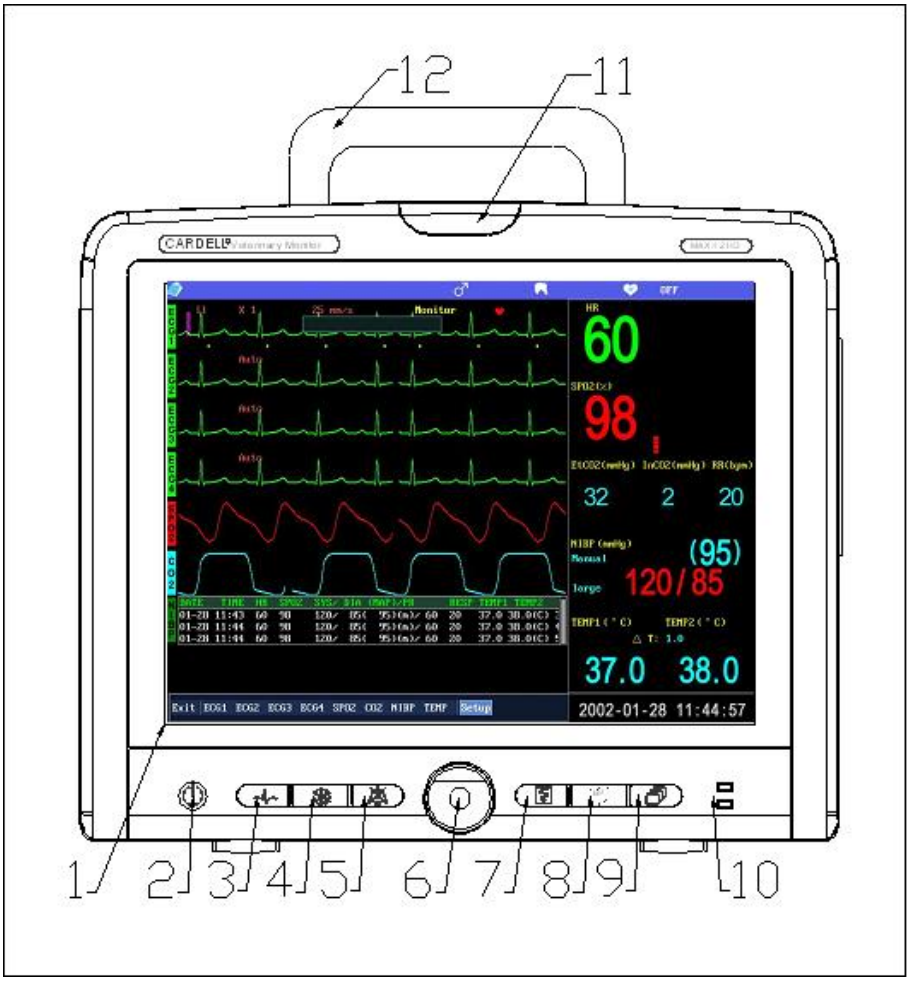


Fig. 3-1 MAX-12HD Front Panel

(1) Display — Color TFT LCD display for displaying waveform, menu, alarm status and vital signs.

(2) Power button — When the patient monitor is connected to A/C power or there is enough battery power, press this button until the monitor turns on or off.

(3) — Paremeter Setup Menus: Press this key to setup each parameter.

(4) — Freeze/Restore: Press this key to freeze/unfreeze the waveform. Note: During waveform freeze status, the monitor will automatically restore waveform sweep after 30 seconds.

(5) — Silence: Press the key to enable/disable the alarm sound.

When alarm is off, the icon at left will appear.

When pressed, the alarm will be silenced for 2 minutes.

(6) — Knob: When in a menu, rotate the knob to scroll through choices and press the knob to make a selection.

From the main display, rotating the knob will scroll through the NIBP history. Pressing the knob from the main display will enter the short-cut menu to adjust alarm volume, HR volume, brightness, Big Font, Night Mode and Work Mode.

(7) — Start/Stop Printing: Press the key to start printing (will automatically print 90 seconds). Press it again

to stop printing.

(8)

Start/Stop NIBP: Press the key to start blood pressure measurement, press it again to stop blood pressure measurement.

(9)

System Setup Menu: Press the key and the system setup menu will be displayed on the screen. Press it again, the menu will disappear.

(10)

Power indicator: AC indicator. When the monitor is connected to AC power, the yellow indicator will remain on. When the patient monitor turned on, the indicator becomes green.

(11) Alarm LED:

Flashing red: indicates a high priority alarm or life-threatening situation.
Flashing yellow: indicates a medium priority alarm.
Steady yellow: indicates a low priority alarm.

(12) Handle

3.2 Rear Panel

The rear panel of MAX-12HD multi-parameter patient monitor is as shown in Fig. 3-2.

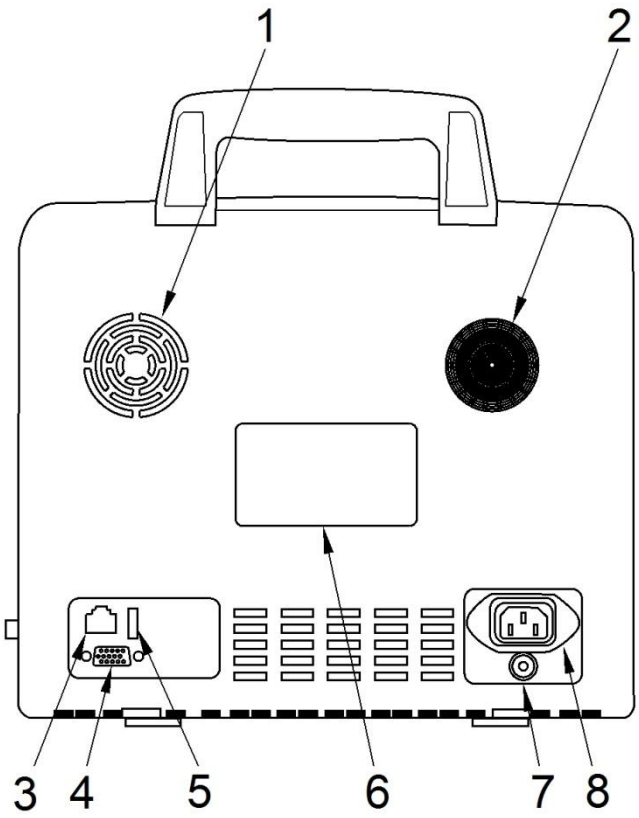


Fig. 3-2 MAX-12HD Rear Panel

1 Fan（For heat dissipation）	2 Speaker
3 Ethernet port	4 Video Out (VGA) port
5 USB	6 Label
7 Equipotentiality Ground Post	8 AC power supply socket

External display port: connect standard color VGA monitor.

3.3 Side Panel

There are eight receptacles on the side panel. See Fig. 3-4.

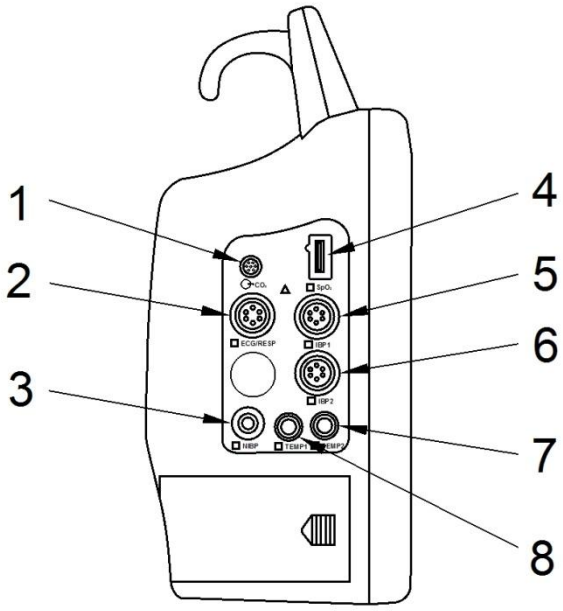


Fig. 3-4 MAX-12HD Side Panel

1: CO_2: C-Stat CO_2 cable connection

2: ECG/RESP: ECG cable connection

3: NIBP: Cuff hose connection

4: SpO_2: SpO_2 extension cable connection

5/6: IBP 1&2: IBP cable (optional) connections

7/8: TEMP 1&2: Temperature probe extension cable connection

⚠ Please check precautions of each parameter in the related sections. IBP 1&2 is an optional parameter.

On the right side panel is the built-in printer; on the left side panel, the two rechargeable batteries are housed.

⚠ To load thermal paper:

To install the paper roll in the printer first lift the smoke-colored latch on the printer compartment. Place the roll of paper between the two round tabs of the paper holder with the paper coming off of the bottom of the roll. Pull enough paper from the roll so it hangs over the door when closed (Do not thread paper under black bar). You are now ready to print.

MAX-12 HD is Class I device with internal power and complies with IEC60601/EN60601 requirements.

⚠ Devices connecting to the patient monitor should meet IEC standards. Data processing device should meet IEC950 and medical devices should meet IEC60601-1. The complete system should meet the latest valid standards of IEC60601-1-1.

BATTERY

Battery Power Supply: 12V 4.6Ah

Whenever the device is plugged into AC power, the two batteries will automatically be charged. They should be charged at least for 8 hours before they become full. To ensure batteries are fully charged, it is recommended to plug the device in AC power even when the device is not being used.

Note: Before the first use, the batteries must be charged.

Note: When the device is being stored for a long time, make sure the batteries are full. Check the battery status at least every month and recharge them.

Each fully charged battery can support the device continuously working for 1.5 hours, however NIBP measurement and printing may accelerate the consumption of battery power. When the battery power is almost used up, the battery mark at the lower right corner of the screen will flash, alerting user to plug the device in AC power as soon as possible. When battery power is not enough to support normal operation of the device, the device will be turned off automatically and will not start to work until being turned on after it is plugged into AC power.

WARNING: Even when the device is not on, battery power will be discharged slowly.

3.4 Before Monitoring

Before monitoring a patient, please check the following:

Check if there is any mechanical damage.
Check the external connections.
Check if the patient monitor is in good working condition.

Warning: If anything is found abnormal or mechanical damage is apparent, please don't use it, and contact Midmark.

Step 1: After power on, the system will start self-test. If the self-test is successful, then start monitoring your patient. If changes are to be made in the operation or settings, see the Operation Procedures.

Step 2: Make sure the patient monitor is connected to the patient through the accessories.

Step 3: Attach probe and transducer to the patient.

Note: The monitor can be used for a single patient at one time.

3.5 Display illustrations

Under normal working conditions, the display screen is as shown in Figure 3-5:

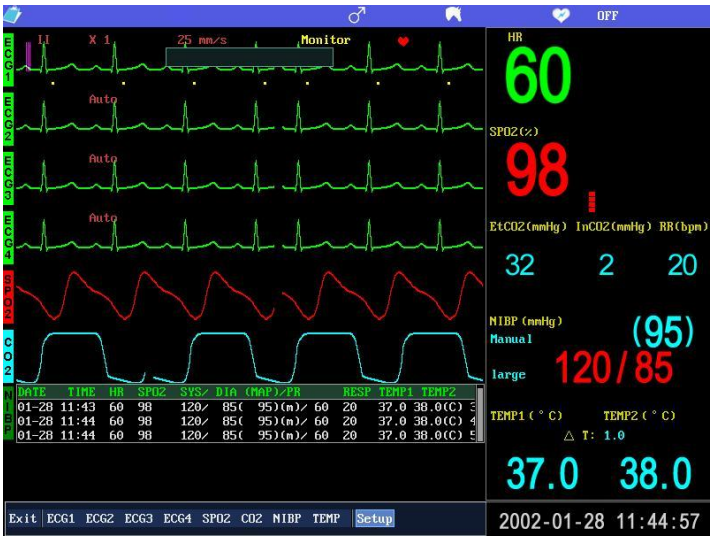


Fig.3-5 Display Screen

The display screen is composed of data area, parameter area and waveform area.

Data Area: shows the data about patient and monitor, such as: patient no., location, sex and patient mode.

Parameter Area: shows monitoring physiological parameters.

Waveform Area: shows monitoring waveform on each channel and alarm events.

Note: The patient mode includes cat, dog, horse and other.

Date and time are displayed on the bottom right of screen.

In the Status Area, you can see battery power status, AC power and alarm status.
Battery power status: The mark is used to indicate the battery power. The more segments, the more power remains.

a) When only two segments remain, the mark starts flashing and an audio alarm indicates battery power is low.

b) When only one or no segment remains, the mark turns to red and flashes with an audible alarm, the power is being used up and the monitor will be powered off within five minutes if not recharged.

c) When AC power plug icon appears in the position of the battery, it indicates that the monitor is being powered by AC power and the internal battery is being charged.

Parameter Area

In the parameter area, the real-time data of the following parameters are displayed: : ♥（HR/PR）, SpO_2, Respiration Rate, NIBP, IBP1, IBP2, CO_2, Temp1, and Temp2.

NIBP parameters displayed are the systolic and diastolic values and mean value.

At the right side of SpO_2 data display area, there is a red bar indicating the signal strength of SpO_2.

When an artery pressure is measured, IBP parameter area displays the systolic and diastolic readings in red color, mean pressure in blue color. When VCP is measured, in IBP parameter area, mean pressure is displayed in red color and its systolic and diastolic pressure readings are displayed in blue. The display position can also be exchanged.

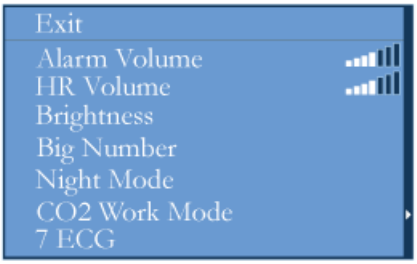
3.6 Menu

Menu offers different selections. The key is used to activate the main menu of the device. The contents of the menu change with the channel setup:

In the main menu line, rotate the knob to point to a key (see above IBP2), and press the knob to enter the sub-menu operations.

After entering sub-menu, rotate the knob to point to a key and press the knob. You can enter the next menu or select a function directly and press the knob to confirm the selection. When finished, rotate the knob to BACK and press the knob to confirm to exit. Then the setting is saved.

Volume and Brightness menu may also be displayed by directly pressing the hot key as follows:



Alarm sound volume has 7 selections. Heart rate sound volume has 7 selections. Display brightness can be adjusted. Under Normal mode, the screen is bright, suitable for monitoring in daytime. When Night mode is selected, the screen is darker, suitable for monitoring at night.

NOTE: If any alarm occurs, the Night mode will be exited.

NOTE: System prevents entering Night mode during alarms.

1. In system setup menu, press to return to the normal monitoring screen.

2. In sub-menu mode, press to return to the normal monitoring screen.

When user has not performed any operations for over 30 seconds, the menu display will automatically disappear and return to full screen.

SECTION 4 ALARM SETUP

4.1 Brief Introduction

Alarms are designed to give an alert when the monitoring results are abnormal. It is rendered with audible sounds, visual LED indicators, and flashing readings. Alarms have three degrees: High priority (Double high volume beeps 5 times every 10 seconds, red LED flashing ½ second), Medium Priority (Single medium volume beep 3 times every 25 seconds, yellow LED flashing every 2 seconds), Low priority (single low volume beep every 30 seconds, steady yellow LED)

High priority Alarm: Asystole, SYS-DIA is too low, Apnea Alarm;
Medium priority Alarm: Parameter values exceed set limits; equipment alarms
Low priority Alarm: Low battery power.

Medium Priority alarm equipment conditions are as follows:

LEAD OFF	LOOSE CUFF
PROBE OFF	AIR LEAK
CUFF POSITION ERROR	OVERPRESSURE
RANGE EXCEEDED	OTHER ERROR
NO WATERTRAP (Optional Multi-gas)	FILTER OCCLUSION
CALIBRATION ERROR	OCCLUSION
LOW SIGNAL	

When sensors or probes are unplugged, the screen will display "Probe off" or "No sensor" and alarm.

Note: When "Asystole" is displayed on the screen, please check for the ECG Gain of the relative channel to see if it is too low to detect heart rate. If so, user can switch the ECG lead or change the source channel for the alarm.

To effectively control the system alarm function, the monitor has alarm ON/OFF and sound volume selection, which can be set through Alarm Setup.

Rotate the knob in main menu, and when the arrow points to Alarm Setup, press the knob to enter alarm setup menu.

4.2 Alarm On/Off

（1）Press the key on the front panel to turn on the system alarm sound or silence the alarm within a period of time. The alarm has the following 4 statuses:

Alarm sound is on.

Alarm sound is off (Must be done in the alarm setup menu)

Alarm sound is turned off for 2 minutes. The time is counted down. But new alarm event may turn the alarm on again.

Note： Press the Silence key on the front panel and at the same time, pay attention to the time display at the lower part of the status area until the desired time duration of silence is reached. The alarm for different parameters may be turned off/on in the parameter setup menus.

During the (silence), a new alarm event may trigger the alarm sound and (Silence) will become invalid. The low battery power alarm is not affected by Silence key. It will always alarm whenever battery power is low.

（2）To turn on or off alarm sound, operate the knob as follows,

→ Rotate the Knob→ Alarm Setup → Press the Knob → Alarm on/off → Press the Knob → On/Off → Rotate the Knob → Press the Knob

When alarm is off (disabled), you will not hear any sound when new alarm events occur. Alarm can be enabled through the alarm setup menu or pressing the Silence key on the front panel.

4.3 Alarm Limits Setup

Alarm limits include upper and lower limits that are user adjustable.

The alarm setup for each parameter can be found in the respective parameter setup menus. In the main menu, rotate the knob to select the parameter and press the knob to confirm. Rotate the knob again to look for the soft key and press the knob. The original alarm reading turns into yellow. Now turn the knob left or right, you may increase or decrease the limit until desired limit is obtained. Then press the knob to confirm.

In the NIBP setup menu, there is SYS-DIA Alarm limit, with range from 0 to 40mmHg. The system default is 20 mmHg and will be saved after power off. If the monitor detects that the difference between the SYS and DIA values are lower than this limit, the system will give a high priority alarm.

Note: After parameter alarm limits are set, they will remain in the system after power off until next setup.

4.4 Alarm Sound Volume

To meet the needs of different users, the main menu offers selection of Volume & Brightness as follows:

→ Rotate the knob→ Volume & Brightness → Press the knob→ Alarm Volume → Press the knob→ Rotate the knob→ 1/2/3/4/5/6/7 → Press the knob

Or directly press the knob and enter Volume & Brightness menu to adjust the alarm volume.

4.5 Default Alarm Limits

To return to the factory alarm setting, i.e., default alarm limits, follow these steps to return to the factory alarm limits for dogs, cats or horses.

→ Rotate the knob→ Default Setup → Press the knob→ Rotate the knob→ Dog/Cat/Horse/Other Default → Press the knob

The default alarm limits of the patient monitor are as follows:

Parameter		Dog	Cat	Horse
HR/PR (bpm)	Upper	180	180	50
	Lower	50	90	24
SpO2 (%)	Upper	100	100	100
	Lower	90	90	90
NIBP SYS (mmHg)	Upper	160	160	160
	Lower	70	70	70
NIBP DIA	Upper	100	100	100

(mmHg)	Lower	40	40	40
SYS-DIA (mmHg)	Lower	20	20	20
Resp (bpm)	Upper	55	55	55
	Lower	5	5	5
Temp (℃)	Upper	40.0	40.0	40.0
	Lower	36.0	36.0	36.0
IBP SYS (mmHg)	Upper	160	160	160
	Lower	70	70	70
IBP DIA (mmHg)	Upper	100	100	100
	Lower	40	40	40
EtCO2 (mmHg)	Upper	60	60	60
	Lower	20	20	20
InCO2 (mmHg)	Upper	10	10	10
	Lower	0	0	0

4.6 Alarm Mode

The device provides two alarm modes, standard and auto, which can be set in the alarm setup menu.

→ Rotate the knob→ System Alarm Setup → Press the knob→ Rotate the knob→ Alarm Mode → Press the knob→ Rotate the knob→ Std./Auto → Press the knob

（1）Standard Alarm Mode

When abnormal event happens, and all alarm functions are on, alarm will persist until a response is received.

（2）Auto Alarm Mode

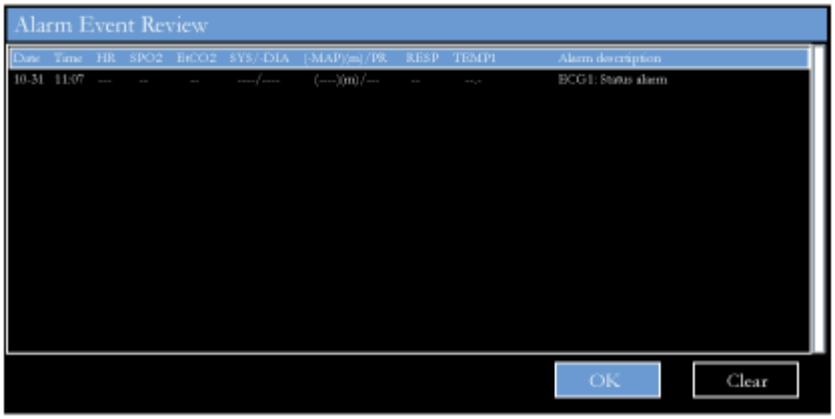
When abnormal event happens, and all alarm functions are on, alarm will last for 30 seconds and display alert message in a proper position.
When blood pressure and temperature values are abnormal (out of limits) and all the alarm functions are on, the alarm sound will last for 30 seconds and automatically turn off, but the readings will continue flashing.
When HR/PR, SpO_2 or respiration readings are abnormal (out of limits), and all alarm functions are on, the device will give real-time sound and flashing visual alarm.

After all alarm setup is completed, rotate the knob to Exit, and press the knob to exit alarm setup.

4.7 Alarm Event Review

→ Rotate the knob→ Alarm Event Review → Press the knob

The content of alarm event review includes Data, Time, HR, SpO_2, $EtCO_2$, SYS/DIA, MAP/m/PR, RESP, TEMP1, Alarm description.


Alarm Event Review
Date Time HR SPO2 EtCO2 SYS/DIA (MAP)(m)/PR RESP TEMP1 Alarm description
10-31 11:07 --- -- -- ---/--- (---)(m)/--- -- --.- ECG1: Status alarm
OK
Clear

Press OK to exit.

Press Clear to delete all of alarm events.

SECTION 5 MONITORING SYSTEM SETUP

Patient monitor setup includes: ECG waveform recall, Trend display, Demo mode, Channel setup, Patient information setup, Date and time setting, Print setup, Volume and brightness setting, Cardiac measurement, Alarm event review, Default setup, System alarm setup, HR/PR priority, Select interface, ECG output channel setup, Network connection setup, About software version, Choose language, Data manager, USB data manager, USB export function, and System maintenance. The system setup menu is as follows:

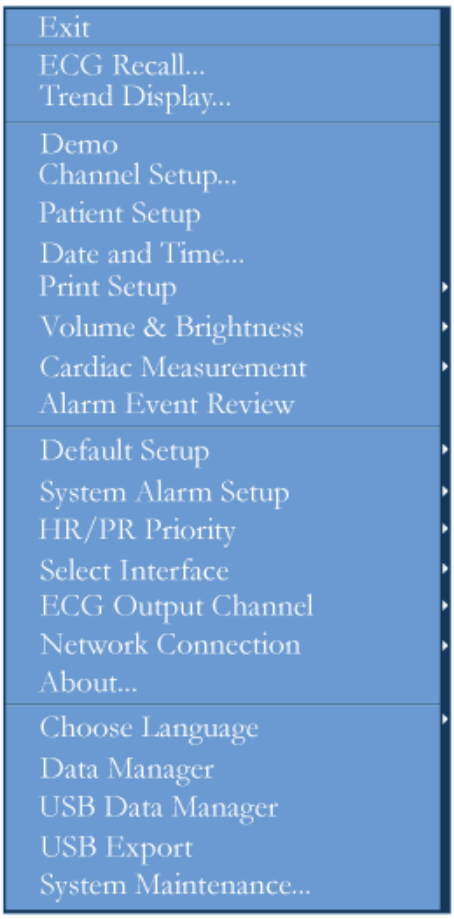


Fig. 5-1 System Setup Menu

5.1 System Setup

Step 1: Press to enter main menu (as Fig. 5-1);

Step 2: Choose required item to set.

5.2 ECG Waveform Recall

Waveform Recall

The past 12-minutes of ECG waveforms can be recalled. When a patient's ECG waveform is abnormal, it can be used to review the waveform. The ECG data comes from the channel where heart rate is detected.

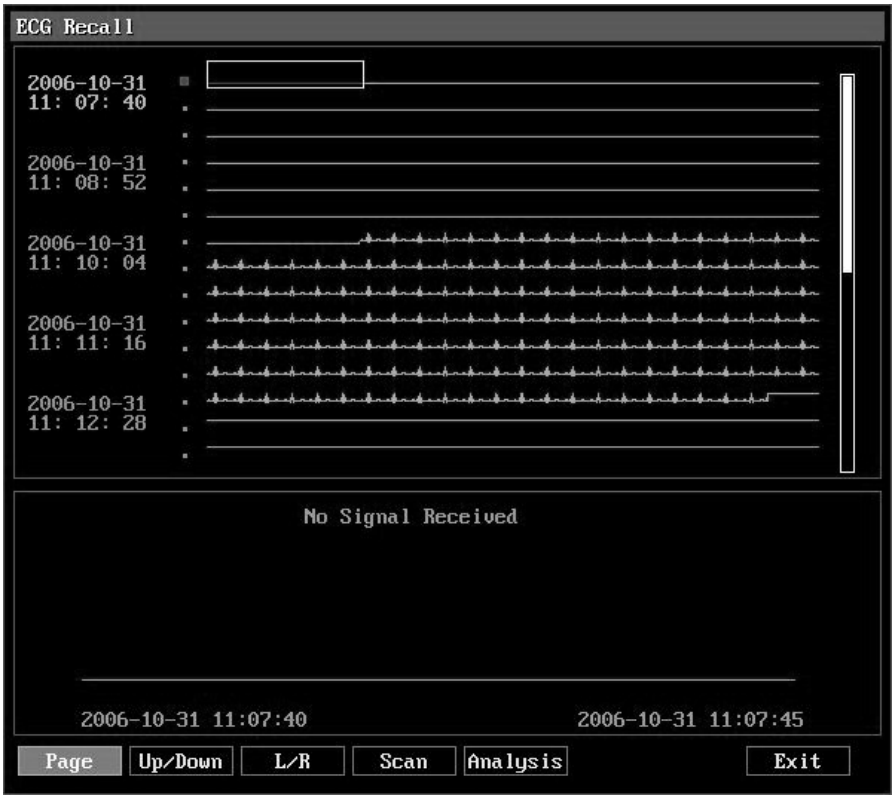


Fig. 5-2 ECG Recall

Display Screen

In the above figure, you can see "ECG recall" on the top of the screen. The status bar at the right side indicates the position and length of the waveform recall. The five time stamps at the left side are the start times of every three lines of recalled waveforms. The first line is 24 seconds, including 4 segments, and each segment is 6 seconds. A segment in red at the bottom of the screen (see next page) is magnified with lead mode and amplitude marked out. The two times at the bottom indicate the start and end time of ECG waveform recall, respectively.

NOTE: The ECG waveform recall speed does not change with the current sweep speed.

In the process of ECG waveform recall, rotate the knob, and you can scroll up and down the ECG waveform in memory.

Press ECG "Analysis", and an ECG segment analysis can be done using electronic "calipers." See figure below:

Fig. 5-3 ECG Analysis

Press "Position", and a base point can be set on the magnified ECG waveform. Then rotate the knob, and the cursor will move along the waveform, displaying measurement information. Move the cursor to change the relative time and amplitude of the point and measure the EGC segment.
Press L/R to select ECG Analysis waveform.

5.3 Trend Display

The device provides up to 120-hour monitoring history data, which can be displayed through trend display function. Follow the steps below to enter trend display:

→Rotate the knob→ Trend Display… →Press the knob

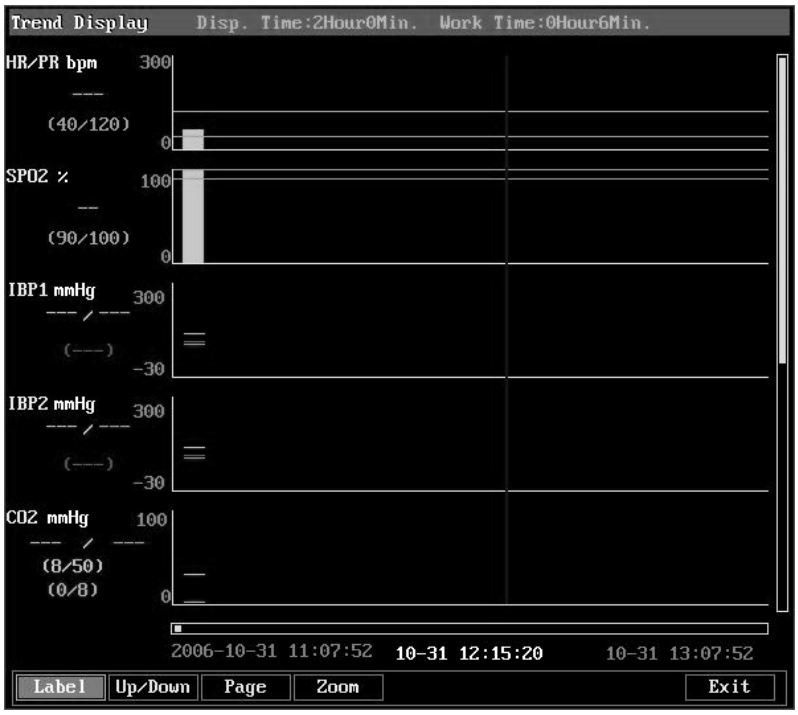


Fig. 5-4 Trend Display

In the "Trend Display", the texts at the left side are monitoring parameter and its upper and lower alarm limits.

In the time status box under graph, the time stamps on the left and right sides indicate the start and end time of the trend. The time in the middle indicates the time where the cursor is. When the actual monitoring time is not enough to be displayed in the full screen, the time at the right side indicates the last trend record time and the time at the left side indicates the start time of monitoring.

The display status bar at the right side of the trend graph indicates whether all of the trend is displayed on the single page. If it is, the status bar is full. If not, it indicates that the trend is not completely displayed and you can press Up/Down to display the trend in the next page.

Note: In the Temp trend display, Temp1 is displayed in blue, Temp2 in green. In the IBP trend display, the blue line indicates SYS, the green line indicates DIA, and the pink line indicates MEAN.
Note: Except for NIBP, TEMP, CO_2 and IBP, all other parameters have two horizontal lines respectively indicating the high and low alarm limits.

The functions of the menu items are as follows:

Move scale: To move the scale and observe different time

Up/Down: To move the trend up and down

L/R: To display previous or next trend

Zoom: To set the time duration of trend display

(2 hours→4 hours→8 hours→24 hours→48 hours→72 hours→96 hours→120 hours)

When finished, press the Main Menu key on the front panel to exit the trend display and return to the main menu screen.

5.4 Demo Mode

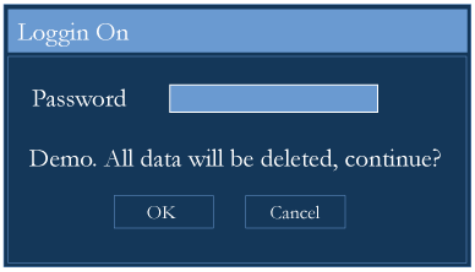
For the purpose of training, the device provides a Demo mode function.

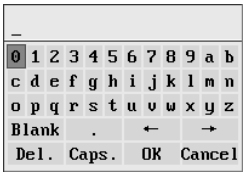
NOTE: Never use this function during patient monitoring!

To enter demo mode:

Press →Rotate knob→ Demo Mode →Press knob

A dialog box will pop up at this time as follows, you should input the password "8727" then choose "ok" to enter Demo mode.





When the device is in Demo mode, you will see "DEMO MODE" on the screen. Press "Demo mode" again to return to normal monitoring mode.

5.5 Channel Setup

The channel setup menu can be entered from the system main menu, and is used to change the channel mode and the parameters of the channels.

Waveform Channel 1 displays ECG1: ECG waveform and indicates ECG waveform speed and ECG mode.

Waveform Channels 2-8 can be selected to display parameters or waveform.

If "Expand" is selected on the Channel Setup menu, the height of the channel above it increases. Selecting "None" displays a blank channel in the parameter area.

The Temperature parameter is displayed at the bottom of the parameter area.

NOTE: If you do not select NIBP channel, the monitor cannot measure NIBP.

Setup

Channel Setup can be set to display parameters on 6 channels or 8 channels.

Step 1: Press knob to enter Channel Setup, press knob to enter channel selection mode and use dial to highlight 6 or 8, press knob to confirm, click on "OK".

Step 2: Rotate knob to select a waveform channel number. Press the knob to enter the parameter selection menu, and turn the knob to highlight the preferred parameter for that channel. Then press knob to select parameter.

Step 3: Press OK. The waveforms and parameters will be displayed on screen according to order.

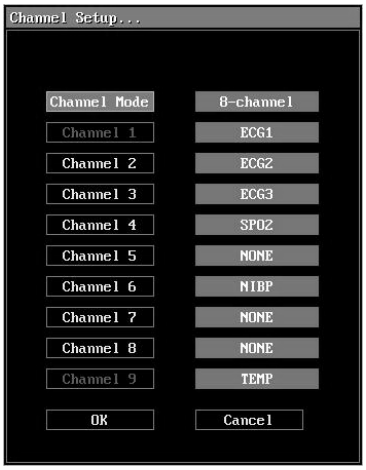
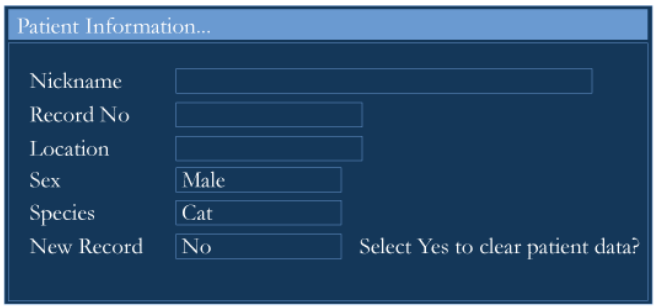


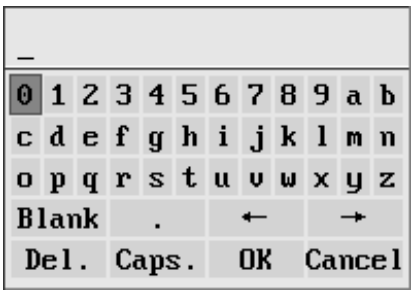
Fig. 5-5 Channel Setup

5.6 Patient Setup

In the monitoring process, patient information can be entered for the ease of observation. To enter the patient setup dialog box:

→Rotate the knob→ Patient Setup → Press the Knob





Patient name, Record number, and Location ID can be entered through rotating and pressing the knob. Then select sex, species and whether it's a new patient (to clear old data). These steps are required if downloading to USB for each patient, and must be done prior to beginning new case.

5.7 ECG and Trend Data Exportation

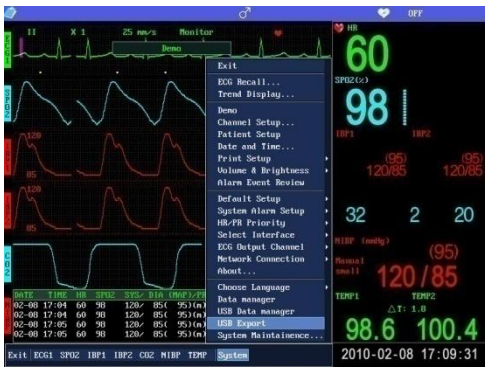
I. Exporting Trend Data and ECG Waveform Data.

Monitoring data that can be exported are Trend Data and ECG Waveform Data.

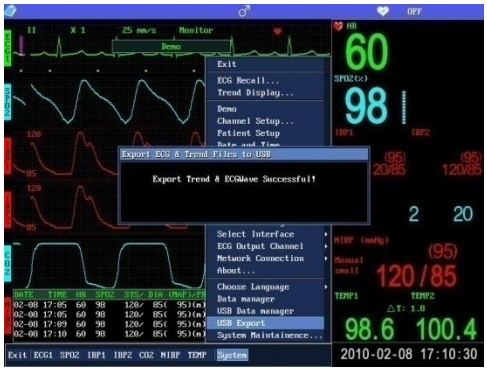
Exporting data:

1. **Make sure the monitor is turned off.**
2. Insert the USB storage device into the USB port on the back of the monitor. (**NOTE: If the USB device is not inserted before the monitor is turned on, it will not be recognized by the monitor**).
3. Turn the monitor on for monitoring. Use monitor as normal until you are ready to download the data.

4. When ready to download the data, select the "System" menu. Scroll down and select "USB Export". This will allow you to record the data taken from the last patient.



5. It takes about 3-5 seconds to copy the data onto the USB storage device. During this process, the waveform and alarm sounds may be interrupted due to the heavy CPU usage.
6. Once the exporting is complete, the monitor will display a message that will indicate if the export was successful or not. "Export Trend & ECG Wave Successful!" means that the data has been exported successfully.



7. NOTE: DO NOT remove the USB storage device! TURN OFF THE MONITOR FIRST! Removing the USB device without first turning off the monitor can damage the USB device and corrupt the data.

NOTE: If exporting of data is used frequently, please keep the USB storage device plugged into the monitor at all times. Since all data stored on the monitor is purged when power is lost or the monitor is turned off, be sure to download the case data before powering down or if running on battery power and a low-battery status message appears. Since you cannot plug in the USB device while the monitor is on, keeping the USB storage device plugged in at all times will allow you to download information when you need to.

TIP: Use the "Patient Setup" menu to clear the data before the start of the case and enter the patient's name and ID. After the case is complete, download the data to the USB device, and then clear the data prior to starting a new case. Doing this will create separate data files on the USB device separated by time and unique to each case and patient.

Transferring data to your PC:

1. Plug the USB storage device into your PC.
2. Select the USB storage device and navigate to the "MAX12" folder. Double click to open it.
3. Select the saved data that you wish to view. The data is saved in Excel format. To view ECG data, select "ECGWAVE". To view all other parameters, select "TREND".

II. Data Format

Data that is downloaded to the USB storage device are saved in excel format. They are also automatically dated and timed, and includes the animal name.

For example:

20091120_140004_Oliver_TREND.xls

20091120 indicates: date of download, Year 2009, November 20th
140004 indicates: time of download, 14:00:04
Oliver indicates: name of Animal

ECG Waveform

The ECG waveform shows twelve-minute continuous waveforms. The excel sheet is capable of storing 120 columns with 3000 groups of data in each column for this data. Each data column corresponds to 6 seconds of ECG waveform: namely 6*500 (sampling rate) = 3000 groups; totaling 3000*120 = 360000 groups. They are organized in chronological order with the first column storing the first 5 seconds of data. This data can also be found in the monitor under "Data Manager" -> "ECG Recall" Menu. The last minute of data is converted into a CSV file and stored in the USB storage device. It is composed of two parts: an information area and a data area.

To see the actual ECG waveforms, highlight all the ECG data and click on "Chart Wizard" on the excel tool bar. Depending on your excel version, you may need to use another graphing tool that came with your excel software.

	A	B	C	D	E	F	G	H	I	J	K
1	Date	Time	Nickname	Species	RecordNo	ECG_Lead	ECG_Gain				
2	9-Feb	4:23:33	Oliver	Dog	16	III	X 1/2				
3	0 second	6 second	12 second	18 second	24 second	30 second	36 second	42 second	48 second	54 second	60 second
4	-16	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
5	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
6	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
7	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
8	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
9	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
10	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
11	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
12	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
13	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
14	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
15	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
16	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
17	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32
18	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32	-32

Trend data can also be found in the monitor under the "Data Manager" -> "Trend Display" menu. When downloading to the USB storage device, the latest 24 hours of data is organized into an excel file. Each row of data is separated by 18 seconds.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Nickname	Species	RecordNo											
2	Oliver	Dog	16											
3	Date	Time	HR	SpO2	NIBP(SYS/	RESP	ETCO2	TEMP1	TEMP2	Innarco_A	IBP1(SYS/I	IBP2(SYS/DIA/MAP)		
4	9-Feb	4:17:33	60	98	-- / -- / --	20	32	370	380	160	120/85/95	120/85/95		
5	9-Feb	4:17:51	60	98	-- / -- / --	20	32	370	380	160	120/85/95	120/85/95		
6	9-Feb	4:18:09	60	98	120/85/95	20	32	370	380	160	120/85/95	120/85/95		
7	9-Feb	4:18:27	60	98	-- / -- / --	20	32	370	380	160	120/85/95	120/85/95		
8	9-Feb	4:18:45	60	98	120/85/95	20	32	370	380	160	120/85/95	120/85/95		
9	9-Feb	4:19:03	60	98	-- / -- / --	20	32	370	380	160	120/85/95	120/85/95		
10	9-Feb	4:19:21	60	98	120/85/95	20	32	370	380	160	120/85/95	120/85/95		
11	9-Feb	4:19:39	60	98	120/85/95	20	32	370	380	160	120/85/95	120/85/95		
12	9-Feb	4:19:57	60	98	-- / -- / --	20	32	370	380	160	120/85/95	120/85/95		
13	9-Feb	4:20:15	60	98	120/85/95	20	32	370	380	160	120/85/95	120/85/95		
14	9-Feb	4:20:33	60	98	-- / -- / --	20	32	370	380	160	120/85/95	120/85/95		
15	9-Feb	4:20:51	60	98	120/85/95	20	32	370	380	160	120/85/95	120/85/95		
16	9-Feb	4:21:09	60	98	120/85/95	20	32	370	380	160	120/85/95	120/85/95		
17	9-Feb	4:21:27	60	98	-- / -- / --	20	32	370	380	160	120/85/95	120/85/95		
18	9-Feb	4:21:45	60	98	120/85/95	20	32	370	380	160	120/85/95	120/85/95		
19	9-Feb	4:22:03	60	98	-- / -- / --	20	32	370	380	160	120/85/95	120/85/95		
20	9-Feb	4:22:21	60	98	120/85/95	20	32	370	380	160	120/85/95	120/85/95		
21	9-Feb	4:22:39	60	98	-- / -- / --	20	32	370	380	160	120/85/95	120/85/95		
22	9-Feb	4:22:57	60	98	120/85/95	20	32	370	380	160	120/85/95	120/85/95		
23	9-Feb	4:23:15	60	98	120/85/95	20	32	370	380	160	120/85/95	120/85/95		
24														

5.8 Date and Time Setup

The device displays the real date and time. Each time the device is turned on, it will display the current date and time.

To enter time setup:

→Rotate knob→ Date and Time →Press knob

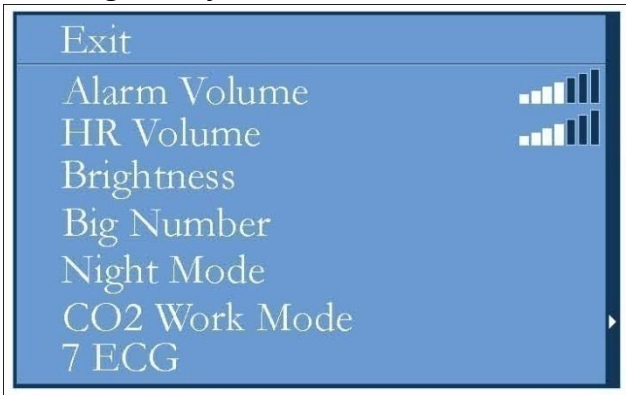
Rotate the knob and press the knob, and you can change the date and time. When the date and time are set, please rotate to OK and press the knob to exit the setup (if "OK" is not selected, the change will be regarded as canceled). If a change is completed and you want to cancel it, then rotate the knob to Cancel, press the knob, and exit. Then the screen will still display

the original date and time.

Fig. 5-6 Date and Time

5.9 Volume and Brightness Setup

Volume & Brightness Setup menu can also be displayed when the knob is pressed at the following hot keys:



The Alarm and Heart Rate volumes have 7 levels. The Brightness adjustment is used to adjust the screen brightness. When "Standard" is selected, the screen is bright, suitable for monitoring in daytime. When "Soft" is selected, the screen is slightly dark, suitable for monitoring during nighttime.

WARNING: If you select Night mode, the monitor display screen becomes dark and all volumes turn off. Before selecting, please consider your patient's status.

NOTE: Night Mode cannot be selected during alarm status.

Press any button (except knob) on front panel to exit Nights Mode. When a new alarm event occurs, the monitor automatically exits this mode.

5.10 HR/PR Priority Setup

→ Rotate the knob→HR/PR Priority→ Press the knob→First Priority/2nd Priority→Rotate the knob→Press the knob

First priority includes ECG/SpO_2/IBP and 2nd priority includes SpO_2/ECG/IBP.

When First priority is selected, heart rate (HR) is first displayed in the parameter area in priority. When ECG is not detected, the parameter area displays SpO_2 pulse rate（PR）or IBP pulse rate（PR）. When no heart rate or pulse rate is detected, the parameter area displays"——".

When 2nd priority is selected, the parameter area first displays SpO_2 pulse rate (PR). When SpO_2 sensor is not connected, the parameter area will display heart rate (HR) or IBP pulse rate (PR). When no heart rate or pulse rate is detected, the parameter area will display"——".

5.11 Display Interface Selection

→ Rotate the knob→ Select interface →Press the knob→ Rotate the knob

→ Enhanced waveform/Big Font/Grid On →Press the knob

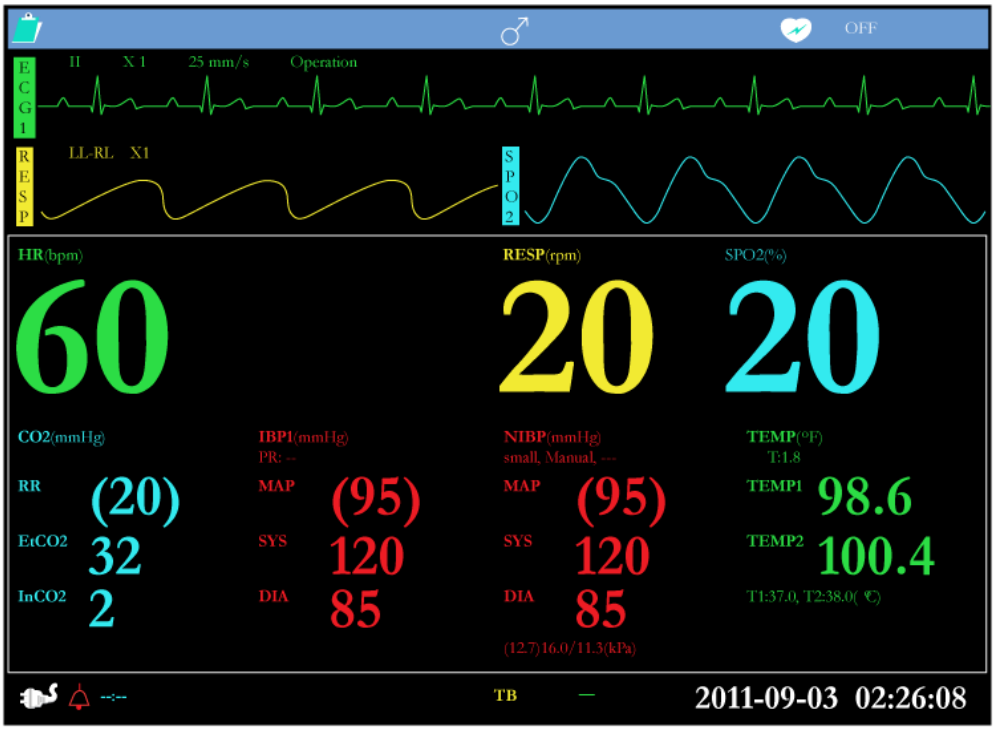
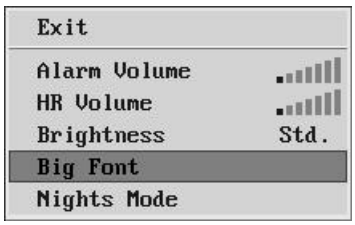


Fig. 5-9 Big Font

From the display interface one can select Enhanced Waveform/Big font (shown as above) and "Grid On", these two kinds of displays are convenient for observing the screen from a long distance. User can select both or neither.

The other method to setup "Big Font" interface: Press the knob, the menu as follow shown will pop-up in the screen, rotate the knob and select "Big Font".



5.12 About…

Fig. 5-10 About

Enter "About…" from the system setup menu, the screen will display software version.

5.13 Choose Language

If you have set English as the Language from the System Maintenance menu, then here, only English can be selected. The system display interface will be the English version.

SECTION 6 PRINTING

6.1 Printer Introduction

Printer Type

The device uses a built-in thermal array recorder and the width of recording waveform is 50mm.

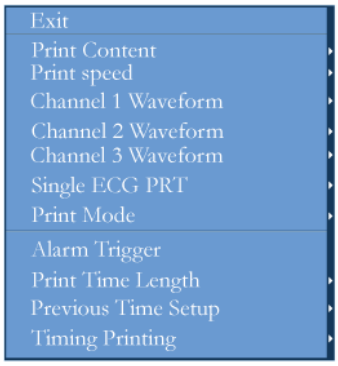
Printer Function

- Adjust waveform speed
- Record waveforms on 3 channels
- Record current parameters and waveforms.
- User can set real-time recorded time, waveform and delay time.
- User can set timing print interval.
-User can select Alarm triggered printing

User can select required printing mode, which includes real-time waveform printing, tabular printing, delayed printing, alarm triggered printing, and automatic printing.

6.2 Printing Setup

In Printing Setup, the user can select the print content, print speed, print channel, printing mode, alarm triggered printing "On/Off," printing length, previous time and auto-print time interval.

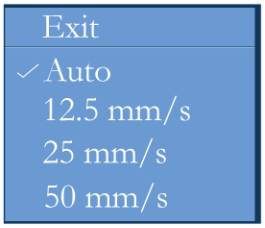


Print content

It is possible to print tabular data or up to three channels of monitoring waveforms. When selecting "waveform", you can start real-time waveform printing through alarm triggered printing, timing printing or by pressing the print button on the monitor's front panel.

Tabular data printing is limited to the last 20 data sets (at 4 minute intervals; totals 80 minutes).

Print Speed: Auto/12.5/25.0/50.00 mm/s



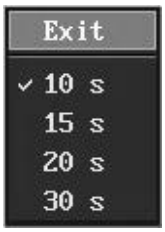
Print Mode: Auto/Default

In auto mode, when alarm is triggered, the alarming parameter waveform will be printed, regardless of parameters selected in print waveform channel setup. In default mode, regardless of the alarm, only parameters selected in waveform channel setup will be printed.

Alarm Trigger printing:

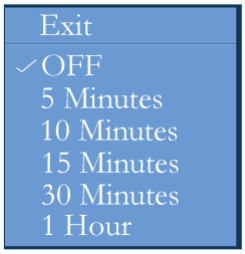
When this function is turned ON, whenever there is an alarm, the monitor will automatically print the data and waveform according to the time selections below. "Advanced Time Setup" means it will print data that led up to the alarm event in the interval chosen.

Alarm Print Time: 10seconds/15seconds/20seconds/30seconds



Advanced Time Setup: 3s/2s/1s/0s

Timed Printing: Monitor will automatically print at the interval selected.



Printing Report Head:

Each time a waveform is printed, a header is automatically printed including the date, time, print speed, and parameter values, including blood pressure units.

Printing Paper:

The printing paper width is 50mm. The paper should be kept in a cool and dry place, away from direct sunlight, high temperature and humidity.

SECTION 7 ECG MONITORING

7.1 General Information

The Cardell MAX-12HD Monitor records heart rate with electrode clips attached to the patient. Electrodes detect signals caused by changes of electrical conduction in the heart during the cardiac cycle. Heart rate is computed on a beat-to-beat basis using the R-R interval of the QRS complex. It is necessary to make sufficient preparations before monitoring in order to get accurate readings.

Patient Cable

The patient cables consist of the main cable (connected to the patient monitor) and the leadwires (connected to the patient).

WARNING: At ECG receptacle, you can see label, which indicates that the signal input part is highly insulated and defibrillator-proof. In addition, it is guaranteed that the monitor will not be damaged during defibrillation and HF surgical operation.

CAUTION: Use only electrodes, ECG cable and leadwires recommended by Midmark.

7.2 Preparations

7.2.1 Skin Preparation and Lead Contact

Sites where leads are attached to the body must be properly prepared to optimize contact. Dogs and cats have enough electrolyte material on their skin and hair so that merely moistening lead sites with 70% isopropyl alcohol is appropriate. This will usually be sufficient for ECG recording/monitoring

for a short time, 30 to 60 minutes, depending upon the relative humidity. For monitoring during longer periods, an electrode paste should be used.
It is best to first wet the hair at the lead attachment site with alcohol; then place paste on the moistened hair and skin. It is important that the paste be in direct contact with skin. For patients with dense undercoat, rub paste with fingers to assure that it has made contact with skin. Crocodile clips are supplied with this monitor and they must opened wide enough to firmly but gently grasp the skin.

7.3 Attaching ECG Electrodes

7.3.1 Leadwires and Color

Table 7-1: 5-Lead Color and Coding

USA Standard	International Standard
LA = black (Left Foreleg)	L = yellow (Left Foreleg)
RA = white (Right Foreleg)	R = red (Right Foreleg)
RL = green (Right Hind Leg)	N = black (Right Hind Leg)
LL = red (Left Hind Leg)	F = green (Left Hind Leg)
V = brown (explore)	C = white (common)

Table 7-2: 3-Lead Color and Coding

USA Standard	International Standard
LA = black (Left Foreleg)	L = yellow (Left Foreleg)
RA = white (Right Foreleg)	R = red (Right Foreleg)
LL = red (Left Hind Leg)	F = green (Left Hind Leg)

7.3.2 Lead placement

Figure 7-1: 5-Lead Placement

For a 5 lead system, four limb leads can be applied (**RA, LA, RL, and LL)** with the exploring lead (**brown**) used for diagnostic purposes as needed. Otherwise, the exploring lead may be left unplugged. Refer to Figure 7-1 and Table 7-1 for more information.

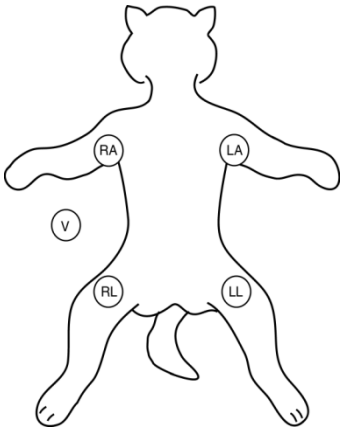
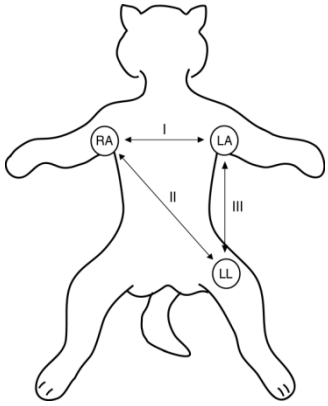


Figure 7-2: 3-Lead Placement

For a 3 lead system, leads should be attached just below the elbow on the front leg and just above the stifle on the hind leg. The following lead sequence should be applied for a 3 lead system: Right Foreleg **(RA-white)**; Left Foreleg **(LA-black)**; Left Hind Leg **(LL-red)**. Refer to Figure 7-2 and Table 7-2 for more information.



POSITIONING ANESTHETIZED PATIENTS

For ECG monitoring during anesthesia, it is most important to position patients properly on the table for the procedure. If standard lead placement as described below is not possible, leads should be attached to the body where they will be least subject to movement and away from the surgical site. It is preferable to view an upright QRS complex for monitoring ECG.

A heart base to apex lead arrangement will be best if the negative lead is

placed at the base (point of right shoulder at thoracic inlet) and the positive lead at the apex (low on caudal left thorax). Standard right forelimb lead is negative and standard left hind leg is positive in lead two; so if these leads are properly placed and the machine is set to Lead II, an upright complex should be the result.

POSITIONING CONSCIOUS PATIENTS

Standard position for recording diagnostic ECG in dogs is right lateral recumbency. Diagnostic tracings can be obtained in cats in either right lateral or sternal position. Limbs should be perpendicular to the spine and parallel with their opposite member. In awake cats and dogs, it is best to have the patient held by a veterinary technician or veterinary assistant. One lead should be applied first to determine comfort level and adjustment made as needed. Then the other clamps can be placed in position. It is important that the patient be kept still. A moving patient may cause clips to saw into skin tissue leading to discomfort and change in position of electrodes.

7.4 ECG Setup

Press the waveform button , then rotate the knob and select ECG knob, finally select required item to setup.

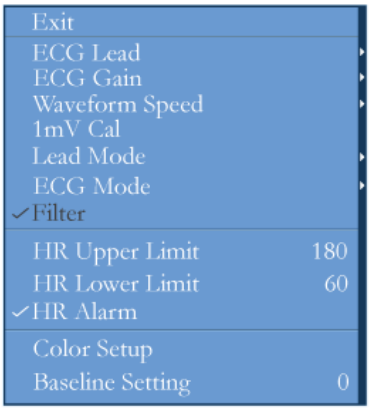


Fig. 7-3 ECG Menu

User may select and confirm by rotating and pressing the knob.

ECG Lead: Select different leads to display different ECG waveforms of a patient.

ECG Gain: Select different waveform gain. User may select x1/4, x1/2, x1, x2, x4 or Auto.

Waveform Speed: Waveform speed options: 12.5/25.0/50.0mm/s.

1mV CAL: When it is pressed, a 1mV square wave will be displayed on the ECG waveform for user calibration.

PaceMaker Detect: I/II/III/V/Off
HR Source: each ECG channel

ECG Mode: operation, monitoring, diagnosis

Alarm Limit: set the upper limit and lower limit of parameters.

Alarm Sound: On /Off

ECG Setup Procedures

Rotate the knob to select and press the knob to confirm.
For example:
Rotate the knob to highlight "Lead".
Press the knob and select the desired item.
Press the knob to confirm.
After setup, rotate the knob to the EXIT icon (the last one), press the knob and exit.

Lead selection

Lead selection is used to select different leads to display different ECG waveforms. User may select I/II/III/V/aVR/aVL/aVF.

Where, I, II, III are bipolar extremity leads and aVR, aVL, aVF are voltage added extremity leads. The positive and negative polarities of the leads are as follows:

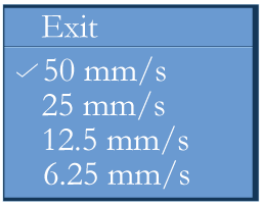
Lead	I	II	III	aVR	aVL	aVF
Positive	LA	LL	LL	RA	LA	LL
Negative	RA	RA	LA	LA+LL	RA+LL	RA+LL

ECG Gain

To change the ECG waveform amplitude, user may select x4, x2, x1, x1/2, x1/4 and Auto. The selected gain is displayed above the waveform channel and the selected value is the amplitude value.

CAUTION: When Auto is selected, ECG waveform height is not calibration significant.

Waveform speed



Select ECG waveform display speed. User may select 12.5/25.0/50.0 mm/s according to the specific needs.

1mV CAL

When it is pressed, a 1mV square wave will be displayed on the ECG

waveform for user calibration.

HR source

User may select ECG1 or ECG 2 or ECG3 or ECG4
ECG 1: to detect heart rate based on ECG 1 signals
ECG 2: to detect heart rate based on ECG 2 signals
ECG 3: to detect heart rate based on ECG 3 signals
ECG 4: to detect heart rate based on ECG 4 signals

NOTE: When using three leads, it only detects HR based on ECG1 signals.

Lead Mode

Three lead and Five lead are options (standard configuration is three lead).

When selecting Five Lead, the ECG leads you can choose are: Ⅰ/Ⅱ/Ⅲ /V/aVR/aVL/aVF and the RESP leads you can choose are: RA-LA, RA-LL, LA –RL, LL- RL.

When selecting Three Lead, the ECG leads you can choose are: Ⅰ/Ⅱ/Ⅲ and the RESP leads you can choose are: RA-LA, RA-LL.

Work Mode

Monitoring /Operation /Diagnosis mode is for the needs of different circumstances. User may set in accordance with the actual needs.

Diagnosis Mode

To display the original ECG waveform which is not filtered.

Monitoring Mode
To display the waveform where interference has been filtered.

Operation Mode
This is only for the circumstances where there are significant interferences outside and ECG waveform has significant distortion (for example operating room). It is not calibration significant.

Alarm sound On/Off
To turn the ECG alarm sound on or off.

7.5 Preparation for monitoring

(1) Select correct electrodes
(2) Connect electrodes to lead wires.
(3) Attach electrodes to the patient correctly.

WARNING: When connecting the electrodes or patient cable, make sure that they do not come in contact with any other conductive material or object (a metal exam table, for instance).

(4) Plug the ECG cable into the ECG receptacle on the side panel of the monitor.
(5) When necessary, adjust the ECG setup.
(6) Set the ECG alarm limits.

7.6 Alarm Setup

ECG monitoring alarms include parameters out of limit alarms and abnormal status alarms. When the monitored parameters are out of the preset limits, the monitor will give an audible and visible alarm.

7.6.1 Alarm Limit Setup

Different parameters have different alarm limits. For different patients, different limits may be required.

(1) Rotate the knob in ECG menu
(2) Enter the alarm limit setup menu
(3) Select the alarm limit of the corresponding parameter.

WARNING: The default alarm limits are designed as general guidelines and for convenience so that values can be reset automatically to common starting points, but these should be adjusted with each patient according to their individual circumstances.

7.6.2 Parameter Adjustment Range:

Parameter	Adjustment Range
HR Limit	15-300 bpm

7.6.3 Abnormal Status Alarm:

Abnormal Status alarm includes "Asystole" and "lead off".

CAUTION: When ECG amplitude is too low, it may result in inaccurate heart rate or Pseudo asystole. We suggest when ECG waveform is too low, change the lead, and adjust to the ECG lead which has maximum amplitude. Otherwise, the monitor may give "Asystole" alarm.

7.7 Precautions

WARNING: When using defibrillator, make sure the electrode and patient cable are not in contact with metal or other conductor surface or grounding devices. During defibrillation, do not touch patient, table or instrument.

WARNING: Ensure conductive parts including electrodes of the patient cable do not come into contact with any conductive surfaces.

WARNING: Do not use the patient monitor during MRI or CT scan.

CAUTION: Leads and cables should be away from patient's neck.

7.8 Cleaning and Maintenance

CAUTION: Please always obey the detailed instructions supplied together with the transducer, which are more updated than the information here. The following instructions shall be treated as general guidance when there is no specific method. When the cable is found worn out or damaged, please replace the cable at once.

7.8.1 ECG cable cleaning

In order to keep the cable dust-free, please clean it with clean cloth with soapy water or a mild detergent.

7.8.2 ECG cable disinfection

In order to avoid long-term damage to the cable, we recommend that you only disinfect the cable when it's necessary according to your hospital regulations.

CAUTION: Do not autoclave the cable.

7.9 Troubleshooting

7.9.1 Inaccurate Heart Rate

(1) check patient's ECG signal

a. check /adjust lead placement

b. check/clean the patient's skin
c. check/replace ECG electrodes

(2) check if ECG waveform amplitude is normal.

7.9.2 No ECG waveform

After leadwires are connected but there is no ECG waveform and the screen shows "lead off" or "no signal received".

(1) Check if the electrodes are in good contact with the patient and if the leadwires are open.
(2) Check all the external connections of the ECG leadwires.
(3) Check the ECG electrodes. Prolonged placement of electrodes may result in polarized voltage and the electrodes should be replaced.
(4) If "no signal received" is displayed on the ECG channel, then the ECG module has communication problem with the main unit. Turn off the machine and turn it on again. If problem still remains, contact Midmark.

7.9.3 ECG baseline shift

ECG scan baseline is not stable on the display.

(1) Check if the working environment is too humid and if the machine has moisture inside. If yes, keep the machine on for 24 hours and keep the ambient environment dry.
(2) Check the electrode quality and whether the skin is clean where the electrode is placed.

SECTION 8 RESPIRATION MONITORING

8.1 General Information

The monitor provides two respiration monitoring methods: thoracic impedance (indirect) and through the CO2 microstream sampline line (direct).

NOTE: If the patient is intubated, direct respiration monitoring through the CO2 sample line is recommended. If you choose to monitor respiration using the thoracic impedance method, place the ECG electrodes on the patient's trunk for more reliable readings.

8.2 Respiration Setup

To enter respiration setup menu,

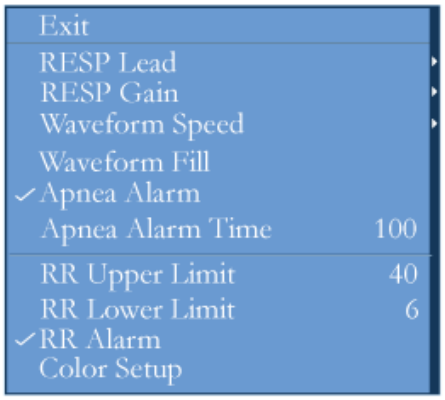


Fig. 8-1 Respiration Setup Menu

Press the waveform button → Rotate the knob → RESP → Press the knob

RESP Lead: While ECG is in Three Lead mode, the lead selections available are RA-LA/RA-LL; if ECG is in Five Lead mode, RA-LA/RA-LL/RL-LA/ RL-LL are available for selection.

RESP Gain: ×½ /×1 /×2 are available for selection. Through selecting respiration gain, the respiration waveform can be zoomed in or out for convenient observation.

Waveform Speed: 6.25, 12.5, 25.0mm/S are available for selection.

Main Menu→Rotate the knob→RESP→Press the knob→Rotate the knob→ Waveform Speed→Press the knob→6.25/12.5/25.0→Rotate the knob→ Press the knob

To fill up RESP waveform :

Main Menu→ Rotate the knob→RESP→ Press the knob→Rotate the

knob→ Waveform Filling →Press the knob

Apnea Alarm : Operator can turn on/off Apnea Alarm as follows,

Main Menu →Rotate the knob→ RESP →Press the knob→Rotate the knob→ Apnea Alarm →Press the knob

Apnea Alarm Time : 5/10/15/20……/120 seconds are available for Apnea Alarm Time selection.

Main Menu →Rotate the knob→ RESP →Press the knob→Rotate the knob→ Apnea Alarm Time →Press the knob→Rotate the knob→ Press the knob

If Apnea Alarm is ON, Apnea alarm will be triggered when the system detects an abnormity according to the Apnea Alarm Time setup. An Apnea Alarm is classified as a high priority alarm.

To set RESP alarm limits:

Main Menu→ Rotate the knob→ RESP→ Press the knob→ Rotate the knob→ RR Upper Limit or RR Lower Limit → Press the knob→ Rotate the knob→ Press the knob

RR Alarm : Operator can turn on/off the RESP Alarm as follows,

Main Menu →Rotate the knob→ RESP →Press the knob→Rotate the knob→ RR Alarm →Press the knob

8.3 Respiration Monitoring Preparation

(1) Place electrodes in proper positions
(2) Select proper respiration lead combination
(3) Set respiration alarm limits

NOTE: Electrodes must be placed in proper positions.

CAUTION: Patient motion may result in a respiration measurement error.

8.4 Alarm Setup

The respiration-temperature alarm includes a parameter out-of-limit alarm and an abnormal status alarm. When the parameter is out of limit, the monitor will give an alarm sound automatically, and the value displayed on the screen flashes at the same time.

Set up alarm limits:
Different parameters have different limits

WARNING: Alarm limits should be adjusted based on an individual patient's condition.

Parameter Range:

Parameter	Adjustment Range
Respiration upper limit	Low limit to 150 bpm
Respiration lower limit	1 to upper limit
Apnea Alarm Time	5-120 seconds

Alarm for abnormal status: "electrode off"

SECTION 9 SpO_2 MONITORING

9.1 Introduction

The MAX-12HD continuously monitors and displays arterial blood oxygen saturation (SpO_2) and pulse rate. The monitor beeps with each pulse beat. It allows you to choose alarm limits and audible tone volumes. You can select the high and low alarm limits for SpO_2 and pulse rate, and independently choose the volume for alarm and pulse beep tones.

The MAX-12HD determines SpO_2 and pulse rate by passing two wavelengths of light, one red (660nm) and the other infrared (940nm), through body tissue to a photo detector. Pulse identification is accomplished by using plethysmographic techniques, and oxygen saturation measurements are determined using spectrophotometric oximetry principles. During measurement, the signal strength resulting from each light source depends on the color and thickness of the body tissue, the sensor placement, the intensity of the light sources, and the absorption of the arterial and venous blood (including the time varying effects of the pulse) in the body tissues.

The monitor processes these signals, separating the time invariant parameters (tissue thickness, skin color, light intensity, and venous blood) from the time variant parameters (arterial volume and SpO_2) to identify the pulse and calculate oxygen saturation. Oxygen saturation calculations can be performed because blood saturated with oxygen predictably absorbs less red light than oxygen depleted blood.

Since measurement of SpO_2 depends on a pulsating vascular bed, any condition that restricts blood flow, such as use of a blood pressure cuff or extremes in systemic vascular resistance, may cause an inability to determine accurate pulse and SpO_2 readings.

CAUTION: SpO_2 sensors are fragile and should be handled with great care.

9.2 SpO2 Sensor

WARNING: Use only Nellcor® veterinary oxygen transducers. Use of other oxygen transducers may cause improper performance.

INSTRUCTIONS FOR USE

NOTE: Reusable sensors may be used on the same site for a maximum of four (4) hours, provided the site is inspected routinely to ensure skin integrity and correct positioning. Because individual skin condition affects the ability of the skin to tolerate sensor placement, it may be necessary to change the sensor site more frequently with some patients.

1) Select a sensor and clip that is appropriate for the patient. There are two (2) sizes of VetSat veterinary sensor clips: model VSC-S (small), and model VSC-L (large).
2) Clean the VetSat sensor and clip separately before and after each use.
3) Open the clip by pressing with the thumb and forefinger.
4) Slide one of the sensor's alignment buttons along the clip slot until the sensor pad is fully engaged in the clip.
5) Slide the second sensor button along the other clip slot until the second sensor pad is fully engaged in its side of the clip.

NOTE: Check that the VetSat optical sensor pads are facing each other.

6) The sensor is now ready to be applied to the patient. The preferred sensor application site for canine, feline and equine animals is on the tongue, with the sensor's optical components positioned on the center of the tongue. Alternatively, the sensor and clip may be applied to the animal's lip, toe, ear, prepuce, or vulva.

NOTE: If the sensor does not track the pulse reliably, it may be incorrectly positioned, or the sensor site may be too thick, thin, or deeply pigmented to permit appropriate light transmission. If any of these situations occur, reposition the sensor or try another sensor site. If the sensor site is covered with fur, try shaving the site and reapplying the sensor.

7) Be sure that the sensor cable is positioned along the side of the animal's face and body to avoid entanglement with the animal.

WARNING: Do not use supplemental tape to adhere the clip and sensor directly to the site; this can restrict blood flow and cause inaccurate measurements. For best results, secure the sensor cable independently from the sensor.

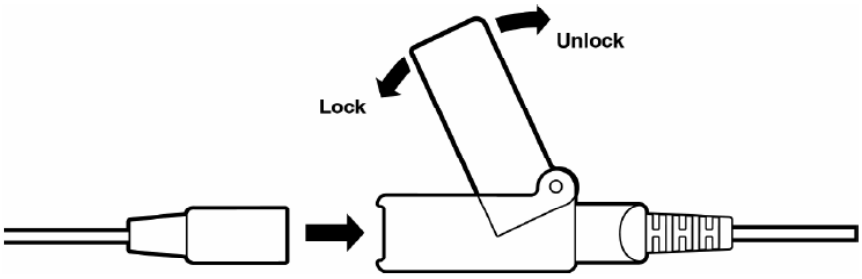
8) Connect the sensor assembly to the Interface Cable:

a) Place the plastic hinged cover in the unlocked position (perpendicular to the connector).

b) Connect the sensor assembly to the Interface Cable.

c) Lock the plastic hinged cover to prevent accidental cable disconnection.

Figure 10: **Sensor to Interface Cable**



9) Plug the Interface Cable into the SpO_2 connector on the side panel of the monitor. Push the cable in until you hear an audible "click".

WARNING: The indicates that the SpO_2 sensor connector is insulated and defibrillation proof which can ensure patient and monitor safety during defibrillation and electrosurgery.

10) Press the ON/STANDBY pushbutton to turn "ON" the monitor.

11) Verify that the sensor is properly positioned by observing at least ten seconds of a continuous pleth waveform being displayed across the screen. When a valid signal is detected, the monitor displays the %SpO_2 and Pulse Rate values. Should the perfusion light be at a low level, reposition the sensor or try a different sensor. If normal operation cannot be achieved, call a Midmark representative for assistance.

NOTE: In addition to the V-SAT sensor and clips that are included with the monitor, there is an optional reflectance sensor, the MAXFAST-1, that can be used on the base of the tail. This is mainly used as an alternative when head/neck/dental procedures are being performed.

9.3 SpO_2 Setup

To enter SpO_2 Setup menu,

Main Menu → Rotate the knob→ SPO_2 → Press the knob

See the menu on the right. Enter waveform speed setup. By rotating the knob and pressing, you can set the sweep speed, the SpO_2 alarm limits and pulse rate alarm limits, and turn the alarm on or off.

For example, to set the SpO_2 waveform speed:

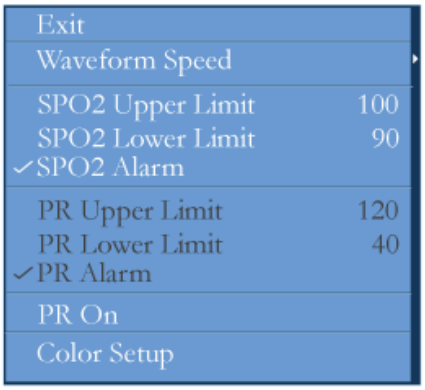


Fig. 10-1 SpO_2 Setup Menu

Main Menu→Rotate the knob→SPO_2→Press the knob→ Rotate the knob→ Waveform Speed→Press the knob→12.5/25.0/50.0mm/S→Rotate the knob → Press the knob

Alarm sound On/Off
To select On/Off
On: To turn on SpO_2 alarm sound.
Off: To turn off SpO_2 alarm sound.

To set SpO_2 alarm limits,

Main Menu→Rotate the knob→ SPO_2→ Press the knob→ Rotate the knob→

SPO_2 Upper Limit→ Press the knob→ Rotate the knob（ increase or decrease the value ）→Press the knob

For alarm limit default setting, see Alarm Setup.

9.4 Preparation for Monitoring

(1) Select the proper size sensor.
(2) Apply the sensor to a proper position on the patient. If possible, keep the sensor at the same level of the patient's heart.

WARNINGS:

- Do not apply the SpO2 sensor to an extremity where there is arterial catheter, blood pressure cuff or injection tube.
- Make sure the light emitting part and light detecting part face each other.
- Make sure the sensor is applied to a region of arterial blood flow.
- Make sure there is no extreme motion.
- Make sure skin where the sensor is applied is neither too thick nor too thin.
- Make sure there is no strong ambient light coming into the sensor. Cover the site with opaque material.

(3) Plug the sensor into the SpO2 connector on the patient monitor.
(4) Set the upper and lower limits of SpO2.

CAUTION: Handle the sensor and the wiring with care. There are sensitive electrical parts in the sensor that can be damaged by negligent treatment. Keep the wiring away from pointed things. Normal wear-and-tear caused by patient motion or sensor cleaning will limit the life of the probe. Longevity can be extended by careful treatment.

WARNING: During prolonged monitoring, check and change the sensor position regularly in order to avoid damage to the patient's skin. Special patients need special treatment.

SENSOR REMOVAL

CAUTION: For the comfort of the patient and to avoid damaging the sensor, do not pull on the cable when removing the sensor and clip from the sensor site, but rather, unclip the sensor and remove from placement site.

When SpO2 monitoring is completed, remove the sensor from the patient.
To remove the sensor and clip from the patient, press the clip open and remove. When the probe is removed from the patient, the message "SpO2 Probe OFF" is displayed and an audible alarm sounds, indicating a connection has been lost. To acknowledge the alarm, press the SILENCE/RESET pushbutton. The monitor silences the audible and visual alarms and the message "SpO2 Probe OFF" remains on the display.

To remove the sensor from the clip, grasp the end of each sensor pad and pull it through to the inside of the clip. The sensor should pop out of the clip easily. DO NOT pull on the cable.

9.5 Alarm Setup

The SpO2 alarm is for parameter out of limit or abnormal status. When the parameter exceeds the limit, the monitor will give both visual and audio alarms.

Alarm Range:

Parameter	Range
Spo2 upper limit	lower limit to 100%
SpO2 lower limit	0 to upper limit
Pulse rate upper limit	Lower limit to 250 (bpm)
Pulse rate lower limit	30 to upper limit

WARNING: If the SpO2 upper limit is set to 100%, then, it is equivalent to no alarm limit.

Abnormal Status Alarm: "Probe Off" alarm

9.6 Precautions

WARNING: Prolonged use or the patient's condition may require changing the sensor site periodically. Change sensor site and check skin integrity, circulatory status, and correct alignment every 2~3 hours. If there is any change, move the sensor to another site.

CAUTION: Clean the sensor surface with 70% ethanol before and after use. But do not immerse it totally into the liquid.

CAUTION: Do not autoclave, ethylene oxide sterilize or radiate the sensor.

9.7 Cleaning and Maintenance

9.7.1 Clean the sensor:

(1) Clean the sensor with a soft cloth moistened in soapy water or mild detergent, saline (1%) or one of the following solutions: Microzid (pure), Mucocit (4%), Incidin (10%), Cidex (pure), Sporicidin (1:16), Mucaso (3%), Buraton (pure), alcohol (pure), Alconox (1:84), Cetylcide (1:63).

(2) Clean the sensor surface with soft cloth and let it dry completely.

(3) Wipe the receiving part and flashing part of the sensor with soft cloth immersed in the detergent or alcohol.

(4) Check the sensor and cable each time before use. If any damage is found, please replace them immediately.

9.8 Troubleshooting

CAUTION: Do not immerse the cable or sensor in any liquid or let the liquid enter into the connectors.

9.8.1 No SpO2 data

Failure Phenomenon:

During monitoring process, there is no SpO2 waveform or data.

Inspection Method:

Check if there the red light on the sensor is on.

Solution:

If there is no red light inside the sensor, the wiring connectors may have

become loose, or the wire inside the cable may have grown frayed over time. Try it on your finger or earlobe, and if no reading is obtained, it may indicate that the V-SAT sensor must be replaced.

If "No signal received" is displayed on the screen, then there is a communication problem between the SpO2 module and the host. Turn off the machine and turn it on again. If the problem still remains, consult Midmark.

CAUTION: Certain drugs, including alpha-2s, are vaso-constrictive, and may cause difficulty in obtaining readings on patient extremities. Moving the sensor further back on the patient's tongue, or exploring alternate sites (lip, ear, toe webbing, prepuce, vulva), may restore the readings.

9.8.2 Intermittent SpO2 value:

Failure Phenomenon:

When patient SpO2 is measured, the SpO2 value is not continuous.

Inspection method:

(1) Patient motion

(2) SpO2 extension cable connection or V-SAT sensor.

Solution:

Keep the patient as still as possible. Value loss caused by patient motion can be considered normal.

SECTION 10 NIBP MONITORING

10.1 General Information

The MAX-12HD uses oscillometric principles to calculate the systolic, diastolic, and mean arterial pressure (MAP) values. The MAP is calculated as the lowest cuff pressure that provides the maximum cuff oscillations. Therefore, MAP is the largest signal received and is the most accurate reading using oscillometric methods. Systolic pressure is calculated as the cuff pressure at which an increase in cuff oscillations is perceived. The diastolic pressure is the cuff pressure when oscillations are no longer decreasing as pressure is released from the cuff. Special veterinary specific algorithms have been designed to ensure reliable and accurate measurements from kittens to horses.

NOTE: See **Appendix 5** for a listing of validation studies on the Cardell® blood pressure and Nellcor pulse oximetry technology.

The patient monitor first inflates the cuff to a pressure of around 20mmHg higher than the systolic pressure, then, slowly deflates the cuff. When the cuff pressure is higher than systolic pressure, the artery is blocked and there are small amplitude oscillometric waveforms. When the cuff pressure is equal to the systolic pressure, the oscillometric amplitude increases. With the decrease of the cuff pressure, the oscillometric amplitude increases. When the cuff pressure reaches a certain value, the oscillometric amplitude reaches a maximum value, then the cuff pressure is mean arterial pressure. It uses the changes of the oscillometric amplitude under different cuff pressures to identify mean pressure and calculate the systolic and diastolic pressure.

⚠ On the NIBP socket, mark indicates the signal input part is insulated and defibrillation protected and patient safety can be ensured. In defibrillation and electrosurgical procedures, the device will not be damaged.

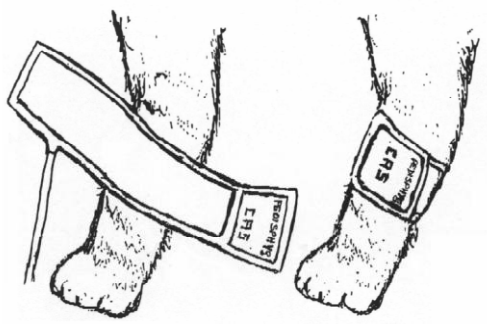
10.2 Cuff Placement

NOTE: Place the patient on a padded surface to provide comfort, and warmth. Shivering will inhibit the monitor from making a determination.

Cuff placement for a cat

A cat may be left in its owner's lap to keep it calm. Measurements are best done in an area of the hospital away from noise and bright lights. The animal may be held so that the front limbs are free for cuff placement. In conscious patients, the tail may be the most appropriate location for placement of the cuff. Cats may be most comfortable in sternal recumbency making the tail a more preferable site. For the median artery on the foreleg, place the cuff around the forelimb, between the elbow and carpus. It is not necessary to center the cuff over the artery which is on the medial side of the leg because of the fully encircling bladder design. Hair need not be clipped except when heavily matted. In cats less than five (5) pounds when measurements are difficult to obtain, place the cuff around the leg above the elbow to obtain measurements from the brachial artery. Measurements from the coccygeal artery may be used by placing the cuff around the base of the tail but not in anesthetized patients.

Cat Cuff Placement

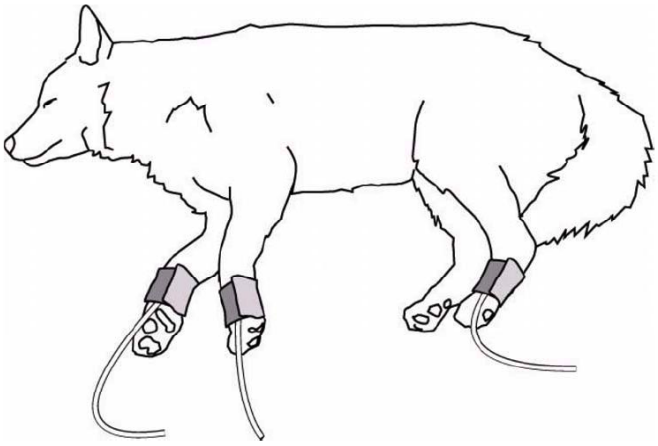


Cuff placement for a dog

For measurements in dogs, it is preferable to use the right lateral, sternal or dorsal recumbent positions. That is not a problem in anesthetized patients, but it may be difficult to get large dogs to cooperate for proper positioning.
If the dog is in a sitting position, place the front paw on the operator's knee and take measurements from the metacarpus. Sites for cuff placement are the

metacarpus, metatarsus and anterior tibial. In anesthetized patients, most surgeries are done on the posterior part of the body so the metacarpal area of the forelimb is most convenient. In situations where this is not possible, the cuff should be wrapped around the metatarsus just proximal to the tarsal pad or around the hind leg just distal to the hock. The tail site should not be used for cuff placement during anesthesia. It is not necessary to center the cuff over the artery because of the fully encircling bladder design. If the hair over the artery site is too thick or matted for good contact, it should be clipped.

NOTE: Use metacarpus or metatarsus.



NOTE: To achieve the most accurate readings, it is important to keep the cuff on a horizontal plane with the heart.

Large animals

A large animal such as a horse should be in a stock, standing still, or lying down. For horses and cows, the cuff can be wrapped around the base of the tail using the coccygeal artery on the ventral surface.

WARNING: When monitoring over an extended period of time, or at frequent intervals, periodically observe the patient's limb to make sure that the circulation is not impaired for a prolonged period of time.

Cuff size selections

The widest cuff that can be placed on the patient, without extending beyond the joint, should be selected. Appropriate sized cuffs may be selected based on

published guidelines that cuff width should be 40 – 60% of limb circumference. The cuff should be wrapped for a snug fit. Overlapping the cuff will not affect measurement results. Make sure the hook and loop sections of the cuff are fully engaged when it is wrapped around the limb. If not fully engaged, the cuff will detach during bladder inflation. If that happens, select the next size bigger cuff. Adhesive tape or other material should not be used to secure the cuff. Use the following table as a guide to select the correct size.

Small Animal Cuff Selection

Reorder Number	Bladder Size (Width)	Limb Circumference Range
SV1	2.0 cm	3-6 cm
SV2	2.5 cm	4-8 cm
SV3	3.5 cm	6-11 cm
SV4	4.0 cm	7-13 cm
SV5	5.0 cm	8-15 cm
SV600 (kit)	Includes all of the above	

Large Animal Cuff Selection

Cuff Model Number	Bladder Size (Width)	Limb Circumference Range
SV8	8 cm	13 – 20 cm
SV10	10.2 cm	18 – 26 cm

References:

Pedersen KM, Butler MA, Ersboll AK, Pedersen HD (2002). Evaluation of an oscillometric blood pressure monitor for use in anesthetized cats. JAVMA 221: 646-650.

Sawyer DC, Guikema AH, Siegel EM (2004). Evaluation of a new oscillometric blood pressure monitor in isoflurane anesthetized dogs. Vet Anaesth Analg 31: 27 – 39.

NOTE: For species specific reference values, see **Appendix 2**.

10.3 NIBP Setup

NIBP setup includes: select measurement ("work") mode, select cuff size, select auto measurement time interval, change NIBP measurement scale, pressure compensation, dynamic blood pressure, adjust alarm limit and turn the alarm sound on or off.

Enter NIBP setup:

Press the Parameter Setup button and press knob to confirm. Rotate to NIBP, press knob to confirm. Users can rotate the knob to select items shown in the following figure and press the knob to confirm:

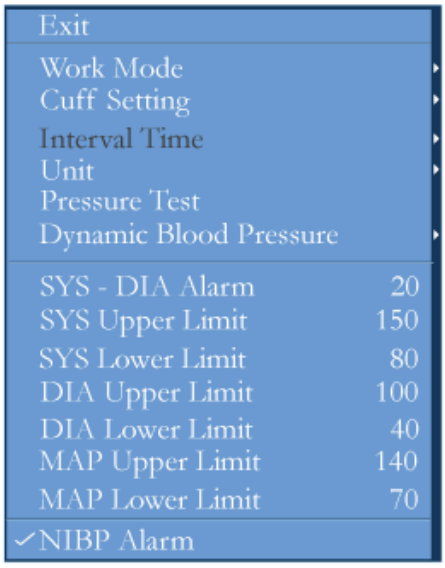


Fig. 10-1 NIBP Setup Menu

Select cuff size: Large/Small
Select work mode: Manual, Auto and Stat
Select time interval for auto NIBP measurement
Change NIBP measurement scale: mmHg or kPa
Press Test: test static press
Dynamic Blood Pressure: Start/Stop dynamic blood pressure monitoring
Alarm limit: adjust alarm upper and lower limits
Alarm On/Off: Turn on or off NIBP alarm sound.

Operation

Method: Rotate the knob to select required function then confirm by pressing the knob.

Select cuff size

The current cuff size is displayed near the blood pressure value on the screen. Large or small can be selected, corresponding to the type of cuff selected for your patient. When using one of the two large nylon cuffs (SV8 or SV10), select "Large." Otherwise, the cuff size should be set to "Small," corresponding to the white cuffs, sizes SV1-SV5.

CAUTION: Before measurement, make sure you have chosen the right cuff size on the monitor.

Select measurement mode: MANU, AUTO, STAT.

NOTE: The current NIBP Measurement Mode will display to the upper right of NIBP parameter.

----Manual (MANU)

Press NIBP Start/Stop button

on the front panel and the NIBP measurement will start immediately.

NOTE: During an NIBP measurement, if the NIBP Start/Stop button is pressed again, the measurement will be stopped immediately.

CAUTION: The initial inflation pressure is 150 mmHg.

----Automatic (AUTO)

The patient monitor will inflate the cuff at the start of each automatic measurement cycle.

NOTE: Anytime during NIBP measurement, pressing the NIBP Start/Stop button will stop the NIBP measurement immediately.

NOTE: In Auto mode, if no NIBP value can be measured, the auto measurement will be stopped automatically.

----STAT

Continuously measure patient's NIBP for 5 minutes. The mode is mainly used to closely monitor a patient's blood pressure changes in emergency situations.

During the STAT measurement, press the NIBP Start/Stop button on the front panel, and the measurement will immediately stop.

Select time interval:

Select time interval in AUTO (displays behind the mode). Adjustable ranges in minutes are 1-10', 15', 30', 60', 90', 120', 180', 240', 480'. The time interval means the time between the last NIBP measurement start to the next NIBP measurement start.

Change NIBP measurement scale: Use this to change the NIBP measurement scale between mmHg and kPa.

NOTE: The measurement scale is shown in the parameter display.

10.4 Preparations before NIBP Monitoring

1) Use cuffs of proper sizes
2) Ensure the cuff has been completely deflated
3) Place the cuff on the patient's limb
4) Install the cuff hose to the NIBP connector of the patient monitor
5) Make sure there is no block between the monitor and the hose
6) Set blood pressure measurement correctly in the setup menu
7) The cuff on the patient's limb should be at the same level as the heart
8) Press the blood pressure start key and start measuring blood pressure

WARNINGS:

1. Make sure there is no other pressure on the cuff.
2. Wrong cuff size may result in inaccurate measurements.
3. Make sure monitor is set to Large/Small corresponding to cuff used.
4. To ensure the patient's safety, never use cuff on the same limb where an infusion is going on.
5. Do not measure SpO2 or other parameters on the same limb where blood pressure is measured.
7. Do not apply cuff on an injured limb.
8. Do not measure a patient's blood pressure continuously or repetitively for a long time.
10. Use only accessories recommended by the manufacturer.
11. Remove the cuff after turning the power off.

10.5 Alarm Setup

10.5.1 NIBP alarm ON/OFF and alarm limits setup

User can activate alarm function and setup alarm limits one by one.

Main Menu →Rotate the knob→ NIBP →Press the knob→Rotate the knob→

SYS-DIA alarm →Press the knob→Rotate the knob→Press the knob

Adjust parameter range

Parameter	Alarm range
SYS Upper Limit	lower limit-254 (mmHg)
SYS Lower Limit	30-upper limit (mmHg)
DIA Upper Limit	lower limit-220 (mmHg)
DIA Lower Limit	10-upper limit (mmHg)

SYS-DIA Alarm 0-40 (mmHg)

The Alarm trigger when the following abnormal events occur and messages will be displayed in the NIBP parameter area: "Cuff loose", "Cuff not connected", "Cuff position error", "Overpressure protection", "Measurement out of limits" or "Measurement error". Take the following steps after seeing the messages:

1. Cuff is too loose, not connected or applied to a wrong position
If the NIBP parameter area displays "Cuff loose" or "Cuff not connected" or "Cuff position error", please check the position of the cuff first, and check whether the inflation hose is damaged.

2. Overpressure Protection

If the NIBP parameter area displays"Overpressure protection," it indicates that the internal inflation circuit results in an NIBP measurement failure. Please contact Midmark for service.

3. Measurement Pressure out of Limit

If the NIBP parameter area displays "Measurement Pressure out of limit", it is because the patient's blood pressure is extremely high and out of the measurement range of the patient monitor. Calm the patient down and perform the measurement again.

4. Measurement Error

If the NIBP parameter area displays "Measurement Error", it may be the result of a system self-test error, the patient being over excited, trembling or air leakage. Calm the patient down and perform the measurement again.
If the message persists, please contact Midmark.

Alarm Sound On/Off: Turn the alarm sound on or off.

10.6 Precautions

The following circumstances may affect the measurement results:
(1) patient motion
(2) rapid change in pressure
(3) shock or hypothermia

10.7 Maintenance

CUFFS

Prior to each patient use, inspect the blood pressure cuff and its hose for damage.

REUSABLE (NYLON) CUFFS

As necessary, for normal cleaning with mild detergents / dilute bleach solution (1-2%), wipe the cuff with the cleaning solution, rinse with water and dry.

NOTE: We do not recommend submersion of the cuff. Liquid should not be permitted to enter the cuff bladder because instrument damage may occur. The cuff should be allowed to thoroughly dry before use.

DISPOSABLE (VINYL) CUFFS

In certain situations, the cuff may become soiled during its use. In these situations a water-based detergent is suitable for wiping the cuff.

As necessary, the preferred method for cleaning the cuff is to wipe it down with a damp, soapy cloth. A damp, detergent-free cloth should then be used to rinse the cuff.

NOTE: We do not recommend submersion of the cuff. Liquid should not be permitted to enter the cuff bladder because instrument damage may occur. The cuff should be allowed to thoroughly dry before use.

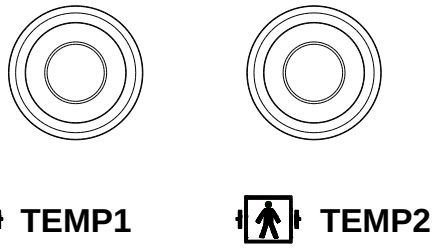
SECTION 11 TEMPERATURE MONITORING

11.1 General Information

A continuous temperature monitor is used to measure a patient's core body temperature during the administration of general anesthesia, detection and treatment of hyperthermia, post-surgical recovery, and other various cases that may require constant body temperature monitoring.

The monitor will display continuous electronic temperature readings or the core body temperature via either a rectal/esophagel probe or skin temperature with an external probe.

Temperature monitoring provides numerical information only - no waveform. As with other parameters, data is displayed in the temperature parameter window on the right side of the screen.



⚠ The signal input is insulated and it is defibrillator-proof. The insulated input ensures patient safety and protects the device during defibrillation and electrosurgery.

11.2 Temperature Setup

Temperature monitoring results are displayed in numeric form only without a waveform.

⚠ Connect temperature probe to patient and make sure the other end of the cable is firmly inserted into the socket in the device. The screen will then display the temperature reading.

Main Menu→ Rotate the knob→TEMP→ Press the knob. Then you can enter the temperature setup menu as shown in the right figure. To set the alarm limits and temperature units, please operate the knob through rotating and pressing it.

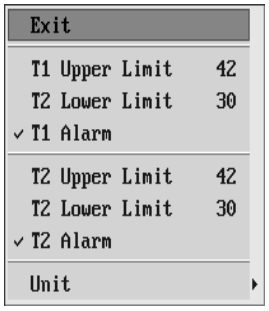


Fig. 11-1 Temperature Setup Menu

For example, to set the temperature unit:

Main Menu→ Rotate the knob→TEMP→Press the knob→ Rotate the knob→Unit Setup→ Press the knob→℃/℉→ Rotate the knob→ Press the knob

To set the temperature channel and alarm limits:

Main Menu→ Rotate the knob→ TEMP→ Press the knob→ Rotate the knob→T1 Upper Limit→ Press the knob→ Rotate the knob（Increase or decrease the value）→ Press the knob

11.3 Temperature Monitoring

(1) Select temperature probe.

WARNING: Skin-surface and rectal probes are not exchangeable.

(2) Probe may be used either in the esophagus or the rectum of the patient.

CAUTION: To avoid cross-contamination, we suggest you label the probe with tape indicating which way it's been used.

(3) Insert the temperature probe into the temperature socket in the side panel.

WARNING: Connect temperature probe with patient and insert the other end of the cable into the temperature socket of the monitor completely. The screen will display the temperature reading.

(4) Set temperature alarm limits.

WARNING: Before performing temperature measurement, do not get the temperature probe close to a heat source. If it has been close to a heat source, then let it cool down for 5 minutes before performing measurement.

(5) Start to monitor patient's temperature.

CAUTION: It takes 10 seconds for the patient monitor to display stable reading.

CAUTION: The patient monitor performs an auto temperature calibration every hour. Should the "Temperature calibration error" message will appear, please contact Midmark.

WARNING: When temperature probe is not connected or temperature probe falls off, the monitor will stop the measurement and display "----" in the parameter area, but without an audible alarm. It is recommended to check the connection of the temperature probe regularly.

SECTION 12 CO_2 MONITORING (Optional)

12.1 General Information

The MAX-12 HD includes the capability to monitor end-tidal CO_2 using the optional Capnostat® CO_2 sensor. This measures CO_2 by using the infrared absorption technique, which has endured and evolved in the clinical setting for over two decades and remains the most popular and versatile technique today.

The principle is based on the fact that CO_2 molecules absorb infrared (IR) light energy of specific wavelengths, with the amount of energy absorbed being directly related to the CO_2 concentration. When an IR beam is passed through a gas sample containing CO_2, the electronic signal from the photodector (which measures the remaining light energy) can be obtained. This signal is then compared to the energy of the IR source and calibrated to accurately reflect CO_2 concentration in the sample. To calibrate, the photodetector's response to a known concentration of CO_2 is stored in the monitor's memory. A reference channel accounts for optical changes in the sensor, allowing the system to remain in calibration without user intervention.

12.2 Capnostat 5 Sensor - Mainstream

The CAPNOSTAT 5 CO_2 Sensor is a mainstream CO_2 sensor. It is factory calibrated and does not require further calibration.

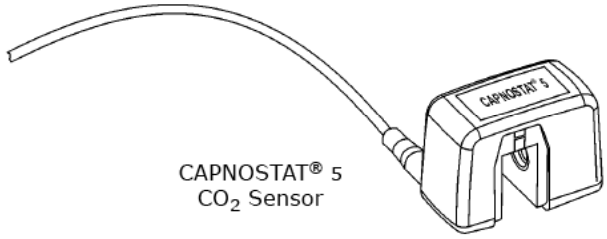


Figure 9-1

Connecting the CAPNOSTAT 5 CO_2 Sensor to the Monitor:

1. Insert the CAPNOSTAT 5 CO_2 Sensor connector into the receptacle of the MAX-12 HD.
2. Make sure the arrows on the connector are at the top of the connector and line up the two keys of the connector with the receptacle and insert.
3. To remove the connector, grab the body portion of the connector and pull back. Do not grab the cord.

Shown below is the CAPNOSTAT 5 CO_2 Sensor connection to a Respironics Novametrix CO_2 adapter

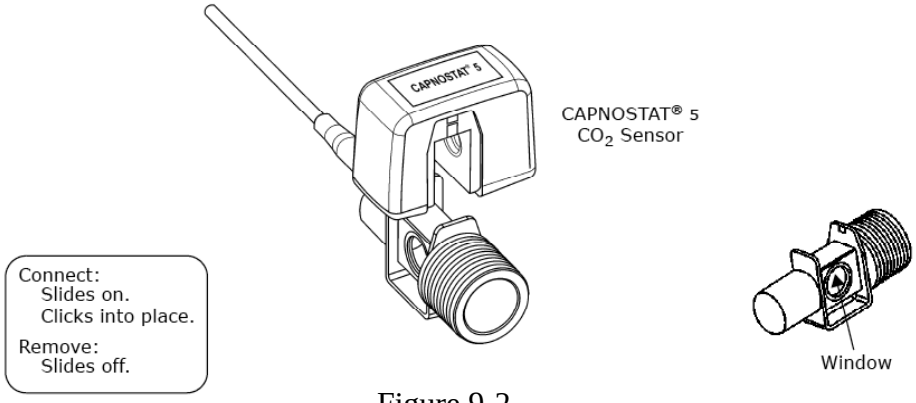


Figure 9-2

Shown below is the CAPNOSTAT 5 CO_2 Sensor with a patient circuit:

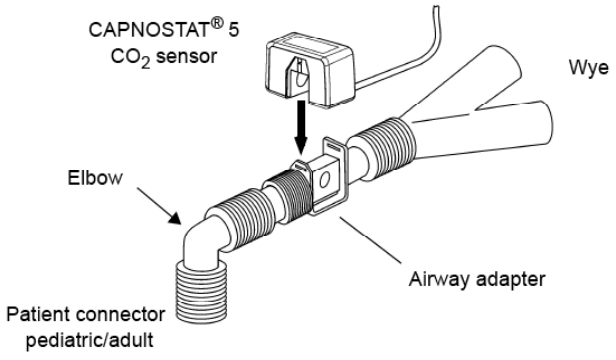


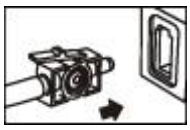
Figure 9-3

12.3 LoFlo CO_2 Sensor - Sidestream

For Sidestream CO_2, the LoFlo CO_2 sensor is provided for your use.

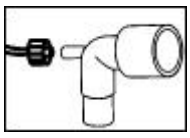
Connecting the LoFlo CO_2 Sensor to the Monitor:

1. Plug the sensor cable into the monitor's CO_2 input receptacle.
2. Wait two minutes to allow the sensor to warm up.
3. Connect the airway adapter or sample line to the sensor. It will click into place when seated correctly.



4. Make sure to Zero your sensor before use. (See section 9.4.)
5. For intubated patients requiring an airway adapter, install the airway adapter at the proximal end of the circuit, between the elbow and the ventilator Y-section.

6. For intubated patients with an integrated airway adapter in the breathing circuit, connect the mail luer connector on the straight sample line to the female port on the airway adapter.

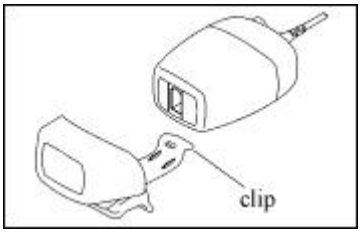


WARNING: Always connect the airway adapter to the sensor before inserting the airway adapter into the breathing circuit. In reverse, always remove the airway adapter from the breathing circuit before removing the sensor.

Using the Sidestream Sensor Holder:

The sidestream sensor holder can be used to clamp the sensor onto an IV pole or a shelf.

1. Push the sensor into the holder until it clicks into position.
2. Clamp the holder onto an IV pole, a shelf, or another appropriate location.
3. To remove the sensor from the holder, release the clip and pull the sensor out of the holder.



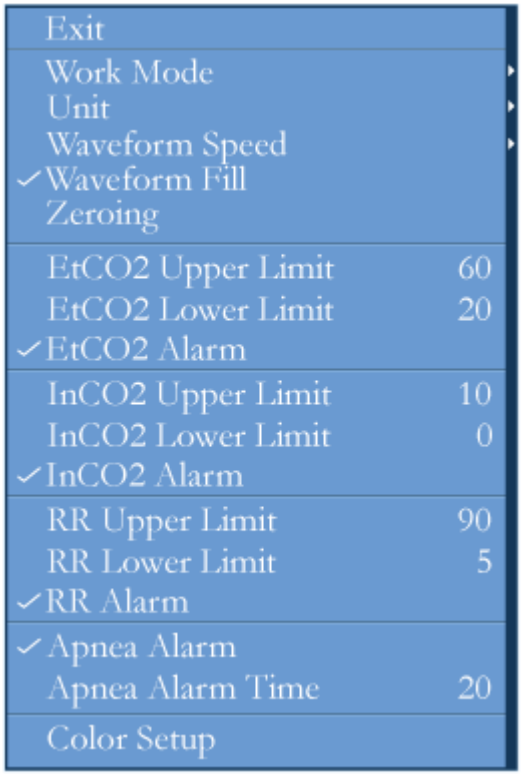
Removing Exhaust Gases from the System:

WARNING: Regarding Anesthetics: When using the sidestream CO_2 measurement on patients who are receiving or have recently received anesthetics, connect the outlet to a scavenging system, to avoid exposing the veterinary staff to anesthetics.

Use an exhaust tube to remove the sample gas to a scavenging system. Attach it to the sidestream sensor at the outlet connector.

12.4 Menu Setup

Push the Menu button to access the parameter icons. Rotate the knob to CO_2 and press the knob to enter the CO_2 Menu.



Work Mode: Choose from Standby or Work Mode.

The monitor will be in Standby Mode when the CO_2 is not in operation. Whenever the CO_2 probe or module is connected, the monitor will default to Work Mode. If not monitoring CO_2, disconnect the cable to slow down the rate of battery depletion.

Unit: Choose from mmHg or kPa

Waveform Speed: Choose from 6.25, 12.5, 25.0mm/s.

The waveform speed represents the sweep speed. The faster the sweep moves across the screen, the more detail will be drawn out. So you will get a bigger waveform that will take up more space on the screen. The slower the sweep moves across the screen, the more waveform gets drawn. This will give the viewer a wider sample of waveforms.

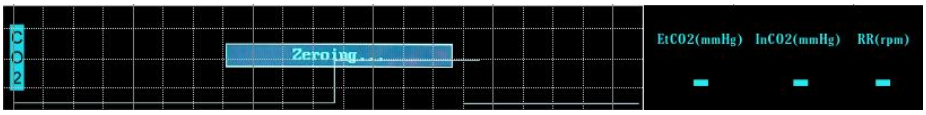
Waveform Fill: Standard waveform is the default for the monitor. Fill is

an option that will color in the waveform instead of displaying it as a line.

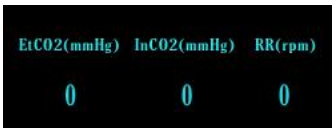
Zeroing: Zeroing is required each time a new type of airway adapter is used or when a sensor is used for the first time. Generally, after an airway adapter is installed, it is only required to be zeroed once. Please note that additional adapter zeroing is required only when prompted by the sensor module.

To perform zeroing:

1. Turn the monitor on.
2. Plug the Respironics CO_2 module into the monitor.
3. Verify that Work Mode has changed from Standby to Work Mode.
4. You will notice that that Zeroing option on the menu has now been grayed out, not allowing you to select it. This is because the module needs time to connect with the monitor.
5. The monitor will connect with the CO_2 module. It takes approximately 5 seconds for the Respironics CO_2 module to perform internal initialization and another 1 minute to warm up.
6. Once the module is warmed up and ready, the Zeroing option will light up again. Click on the Zeroing option to Zero the module.
7. The menu will go away and you will be returned to the main screen. There will be a message where the CO_2 waveform would be flashing: "Zeroing…" The values to the right side of the waveform will display a horizontal bar, indicating that there is no value available.



8. When Zeroing is complete, the flashing Zeroing message will disappear. The values to the right side of the waveform will display a 0 in each column.



9. The module is now ready for use.

$EtCO_2$ / $InCO_2$ / RR Setup:

The monitor user can set upper and lower limits for these parameters depending on the patient's circumstances. Rotate and press the knob to navigate through the parameters.

EtCO2 Upper Limit
EtCO2 Lower Limit
EtCO2 Alarm
InCO2 Upper Limit
InCO2 Lower Limit
InCO2 Alarm
PR Upper Limit
PR Lower Limit
RR Alarm

Color Setup:
This menu allows you to allocate the color of your choice to the waveforms and displays for each parameter.

12.5 Cleaning & Maintenance

CAPNOSTAT 5 CO_2 Sensor
Cleaning the outside of the CAPNOSTAT 5 CO2 Sensor:

1. Use a cloth dampened with isopropyl alcohol 70%, a 10% aqueous solution of sodium hypochlorite (bleach), disinfectant spray cleaner such as Steris Coverage® Spray HB, ammonia, or mild soap.
2. Wipe down with a clean water-dampened cloth to rinse and dry before use. Make certain that the sensor windows are clean and dry before reuse.

Airway Adapters

1. Clean by rinsing in a warm soapy solution followed by soaking in a liquid disinfectant such as isopropyl alcohol 70%, a 10% aqueous solution of

sodium hypochlorite (bleach), a gluteraldehyde 2.4% solution such as Cidex®, Steris System 1® or ammonia. It should then be rinsed out with sterile water and dried.

2. May be disinfected using the methods listed below:
    a. Immerse and soak in Cidex® or equivalent 2.4 glutaraldehyde solution for a 10 hour soak.
    b. Immerse and soak in Perasafe® or equivalent peracetic acid .26% solution for a 10 minutes. Cidex® OPA - follow the manufacturer's instructions for use.
3. Before reusing the adapter, ensure the windows are dry, residue free and that the adapter has not been damaged during handling or the cleaning/disinfecting process.

CAUTION: Do not insert any object, such as a brush, into the CAPNOSTAT 5 CO_2 airway adapter. Irreparable damage may occur to the CO_2 windows.

SECTION 13 IBP MONITORING (Optional)

13.1 General Information

The device displays the maximum systolic pressure, minimum diastolic pressure, mean pressure and an IBP waveform. The IBP waveform can be observed in different channels, and the waveform speed is the same as that of the ECG waveform. In the IBP waveform channel, there is a scale on the top and at the bottom, and at the right end of the line, the IBP reading is displayed.

NOTE: For a thorough discussion, see **Appendix 4**; Direct Blood Pressure Monitoring, by Marc R. Raffe DVM, MS, DACVA, DACVECC, IVECCS proceedings.

13.2 Transducer

IBP transducers provided are in conformity with ANSI/AAMIBP23-1986 standards and with sensitivity 5uV/V/mmHg. Check transducer cable before connecting it to the device.

WARNING：The disposable transducer is for single use only. Never attempt to reuse the parts. Discard the used transducers properly.

Transducer zeroing is very important for accurate measurement. So zeroing should be performed regularly.

1. When the screen prompts "Please do calibration", user may enter IBP Setup to give command:

Main Menu→Rotate the knob→IBP1/2→Press the knob→Zeroing

Mode → Press the knob

If the zeroing mode is set to Manual, after the system prompts zeroing is correct, it will pop out Zeroing Mode. Now press the knob, and you will enter IBP measurement status. If the zeroing mode is set to Auto, after the system prompts that zeroing is correct, it will automatically enter IBP measurement status without necessity for the user to confirm.

13.3 IBP Setup

Before IBP monitoring, make the following preparations:

- Set IBP channel and labels
- Select IBP waveform display scale
- Set alarm limits
- Connect transducer
- Zero the transducer

The IBP Setup function is mainly used to set the IBP gain, IBP label, alarm limits and IBP zeroing. The IBP Setup menu is as follows:

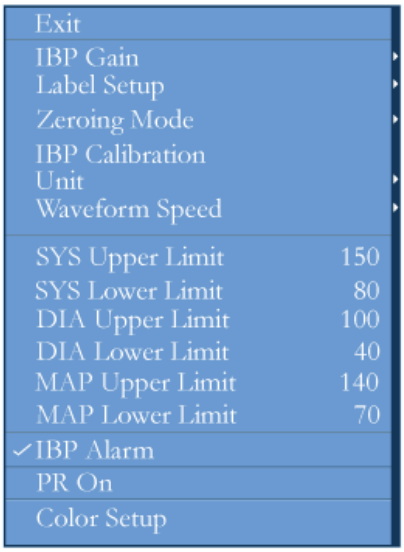


Fig. 13-1 IBP Setup Menu

Fig. 13-2 Label Setup

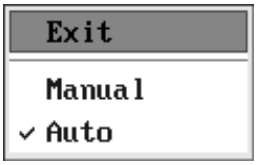


Fig. 13-3 Zeroing Mode

IBP Gain

Different IBP gains correspond to different waveform display scales. The device provides auto selection of optimal waveform gain (Auto) and manual waveform gain (Manual). In the IBP waveform channel, there is a scale line on the top and bottom. At the right end of each line, there is an IBP value corresponding to the level. The difference between the two IBP values is the selected gain value (20/40/60/80/120/180/240/330/Auto).

NOTE: Each time the machine is turned on, IBP is set to be manual zeroing and gain is set to be 330. The setting can be changed but will not be saved after power off.

To set the gain:

Main Menu→Rotate the knob→IBP1/2→Press the knob→Rotate the knob→IBP Gain → Press the knob→ 20/40/60/80/120/180/240/330/Auto →Rotate the knob→Press the knob

Zeroing Mode

Zeroing has auto and manual modes.

Main Menu→Rotate the knob→IBP1/2→Press the knob→Rotate the knob → Zeroing Mode→Press the knob→Auto/Manual→Rotate the knob → Press the knob

① Manual Zeroing

If zeroing mode is set to be "Manual", then the system will automatically enter IBP Setup Menu and IBP Zeroing "Yes" status. Press the knob, and the system will start zeroing.

② Auto Zeroing

When the screen prompts "Press Zeroing Key", if the zeroing mode is set to be Auto, then the system will automatically give the command and start

zeroing, and the user does not need to confirm.

③ Enforced Zeroing

When the transducer needs to be calibrated, please enter IBP Setup Menu and set IBP1/2 Zeroing status to be "YES". Such manual zeroing mode is also called "Enforced Zeroing". Follow the steps below:

Main Menu→Rotate the knob→IBP1/2→Press the knob→IBP Zeroing→Press the knob

IBP Labeling

IBP Labels: IP/ART/AO/RA/FA/PA/CVP/ICP

IP：Invasive blood pressure, default label

ART：Artery Pressure, i.e. the arterial blood pressure being monitored

AO：Aorta Pressure

RA：Radial Artery Pressure

FA： Femoral Artery Pressure

PA：Pulmonary Artery Pressure

CVP： Central Vein Pressure

ICP: Intracranial pressure

When a waveform channel is set to display IBP in the Display Channel Setup (Max. 2 channels for IBP) , you may select the labels in IBP Label Setup, so as to identify the measurement location. The IBP labeling methods are as follows:

Main Menu→Rotate the konb→IBP1/2→Press the knob→Rotate the knob→IBPLabeling→Press the knob→ IP/ART/AO/RA/FA/PA/CVP/ICP → Rotate the knob→ Press the knob

NOTE: When an artery pressure is selected to be measured, the IBP parameter area mainly displays the SYS and DIA displayed in red letters and the mean pressure displayed in blue letters. When CVP is measured, IBP parameter area mainly displays the mean pressure displayed in red letters and the values of its SYS and DIA are displayed in blue letters.

IBP Unit

The device provides two units for displaying IBP measurements, e.g., mmHg or kPa (default is mmHg). The unit can be set in Scale Setup.

Main Menu→ Rotate the knob→IBP1/2→Press the knob→Rotate the knob→unit→Press the knob→mmHg/kPa→ Rotate the knob→ Press the knob

The change in IBP units will be displayed in all the IBP areas, e.g. parameter area and trend graph.

Alarm Setup and Printing Setup

After the above setup is completed, the alarm limits for the SYS and DIA of IBP1/2 need to be set.

Main Menu→ Rotate the knob→IBP1/2→ Press the knob→ Rotate the knob→ SYS Upper Limit→ Press the knob→ Rotate the knob（Adjust the value）→ Press the knob

For the defaults of IBP alarm limits, see Section 4 Alarm Setup.

IBP Alarm can be turned On or Off separately:

Main Menu→ Rotate the knob→IBP1/2→Press the knob→Rotate the knob→IBP Alarm→ Press the knob

To print, set the No. 2 channel to be IBP1 or IBP2 in the Printing Setup:

Main Menu→Rotate the knob→System Setup→Press the knob→Rotate the knob→ Printing Setup→ Press the knob→ Rotate the knob→Channel 2 Waveform→Press the knob→SPO2/IBP1/IBP2/CO2/RESP→Rotate the knob→ Press the knob

The above setup will remain after power off.

13.4 Transducer Connection

1. When the device is turned on, the IBP channel will display "No transducer" and alarm sound can be heard.
2. Plug transducer cable into the IBP or IBP2 socket, and alarm will stop indicating the connection is correct. The other end of the transducer cable is connected as follows:

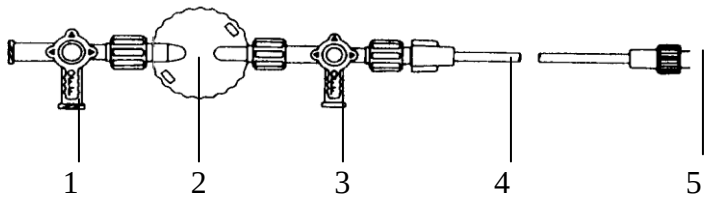


Fig. 13-4 IBP Transducer Connection Diagram

① The T (1) is used to make (2) to be open to the air.

② The T (3) is used to block (2) from (3) and (4).

③ The pressure monitoring tube (4) is to ensure the accuracy of the measurement.

④ The (5) in the above diagram is to connect patient catheter.

1. Fill in the catheter system from T (3) and make sure there is no bubble in the system.

2. Connect patient catheter to pressure monitoring tube, make sure there is no air in catheter, pressure monitoring tube or transducer.

WARNING: If there is bubble in the pressure tube or transducer, flush the catheter system with physiological saline.

13.5 Alarm Setup

IBP monitoring alarm includes parameter limit alarm and abnormal status alarm. Alarm is to give alert when the monitoring results are abnormal. It is audible and visual with LED indicators and flashing readings.

Note: Adjust default alarm limits according to the circumstances and the patient status.

Parameter Limit Range:

Parameter	Range
SYS Upper Limit	lower limit-300 (mmHg)
SYS Lower Limit	-30-upper limit (mmHg)
DIA Upper Limit	lower limit-300 (mmHg)
DIA Lower Limit	-30-upper limit (mmHg)
MAP Upper Limit	lower limit-300 (mmHg)
MAP Lower Limit	-30-upper limit (mmHg)

NOTE: If CVP mode is selected, there is no SYS and DIA alarm.

13.6 Precautions

WARNING: If liquid enters the monitor, turn it off immediately, and contact Midmark.

WARNING: When the monitor is connected to electrosurgical units, make sure the transducers and cables do not contact the electrosurgical unit. The patient lead and conducting wire must be far away from the operating table and other devices. Electrosurgical unit should be properly grounded.

WARNING: When a defibrillator is used, make sure patient cable has no contact with metal or other conductor or device grounding part. During defibrillation, do not touch the patient, table or device.

WARNING: Use only the recommended IBP cable and transducers.

13.7 Troubleshooting

If the IBP waveform channel displays "Calibration Error", please re-enter the IBP Setup menu and press the Zeroing key. If the "Calibration Error" prompt still exists, replace the transducer.

If the IBP waveform channel displays "No signal received", please turn off the machine and turn it on again. If the prompt still exists, please contact Midmark for help.

If the IBP value has a big difference from your expected value, please perform zeroing again by following the steps in section 13.3 describing Transducer Zeroing before performing IBP measurement.

SECTION 14 MULTI-GAS MONITORING (Optional)

14.1 General Information

The multi-gas module measures CO_2, N_2O, and one of the five anesthesia *gases (Halothane, Isoflurane, Enflurane, Sevoflurane, Desflurane). Each gas* is displayed in a monitoring channel, with waveforms showing minimum inhalation volume and maximum exhalation volume.

NOTE: Each channel displays only one gas at a time.

Gas Measurement：

The infrared method is used in the multi-gas measurement.

14.2 Installation and Connection

Parts:
Multi-gas module
Multi-gas module connecting cable
Water trap/filter
Gas sampling line
Standard gas tube connector (t-tube with sampling line connector port)
Gas evacuation line
Anesthesia machine gas tube connector

CAUTION: In order to protect the module from contamination and for the accuracy of data measurement, a water trap for filtering out the moisture and bacteria must be used. Without the filter, bacteria and moisture may enter the Multi-gas module directly, resulting in contamination of the system, occlusion, faulty reading, and damage to the module itself. Empty the water trap before it fills, and replace it regularly to avoid contamination.

Installation Procedures:

The multi-gas module is an external and independent part of the Cardell® MAX12-HD patient monitor.

CAUTION: In order to ensure good ventilation of the module, please keep minimum 5cm from each side from the wall or cabinet.

NOTE: Do not let condensed water accumulate on Gas sampling line or water trap. It is recommended to place the Multi-gas module in a place higher or in the same level of patient position.

Connect multi-gas module to the UT4000F PRO patient monitor enclosure.

Multi-gas Exhaust

If N_2O and/or other inspired anesthetic gas are used, make sure to avoid operating room pollution. Once a gas sample is passing through the "multi-gas module", it must be sent to the anesthesia circuit. Otherwise it must be removed from the anesthesia circuit.

Sending anesthetic gas to anesthesia circuit

To send anesthetic gas to anesthesia circuit, the following accessories are required:

An anesthetic gas exhaust tube
Anesthesia machine gas circuit connector

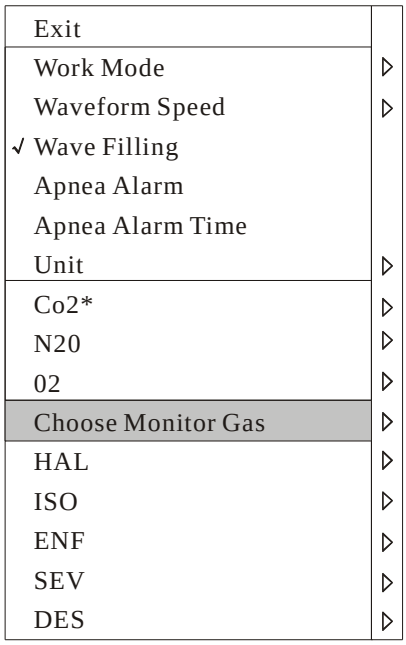
1.Connect one end of anesthetic gas exhaust tube to Anesthetic gas exhaust outlet.
2.Connect anesthesia machine gas tube connector to anesthesia machine patient circuit (exhalation).
3.Connect the other end of anesthetic gas exhaust tube to the anesthesia machine gas tube connector.

Exhausting Anesthetic gas

To exhaust anesthetic gas from anesthesia circuit, please connect exhaust gas clearing
system to the multi-gas module. The following accessories are required to be connected:
An anesthetic gas exhaust tube
A "ventilator gas storage box", with inhalation pressure no higher than 0.3~0.4mmHg, or an exhaust gas clearing connector.

14.3 Menu

Multi-gas Measurement Menu:



Work mode	Select Standby mode or Measurement mode
Waveform speed	Set the speed of waveform
Wave filling	Select to fill in the waveform or not
Apnea alarm	Apnea alarm On/Off
Apnea alarm time	Setup apnea alarm time

NOTE: The patient monitor has a smart alarm function. It will not activate alarm during the period when the patient monitor is just powered up. Instead, it will only activate alarm after it has detected breath and there is a stop in the breath later.

Unit	Select mmHg or kPa
Alarm limit	Set parameter alarm limits
Choose Anesthetic Gas	Select HAL, ISO, ENF, SEV, DES

14.4 Monitoring

1.When the patient monitor is powered on, the multi-gas module will be powered on automatically. Then, connect patient and warm up the module.

2.Install the water trap in the water trap holder in the front panel of multi-gas module.

3.Connect one end of gas sampling line to the water trap, turn it clockwise to make sure it is connected tightly. To disconnect the water trap from gas entrance of multi-gas module, turn the connector at the top of gas sampling line counterclockwise.

4.Connect the other end of gas sampling line to patient loop with standard gas tube connector (t-tube).

5.Connect anesthetic gas exhaust tube to the rear panel of module, and connect "anesthesia loop" or "evacuation" pipe.

6.Start Anesthetic Agent Monitoring

(1) Select corresponding display channel in setup menu.
(2) From the display mode, the module will enter "Standby mode" in about 2-3 minutes.
(3) If inhaled anesthetic gas is to be measured, please select the

corresponding anesthetic gas in menu.

(4) Select "Measurement mode" from the "work mode" menu, and in a few seconds, Zeroing will be displayed. Zeroing takes about 2 minutes, then it automatically enter s Measurement mode.

(5) In Measurement mode, the channels of the waveform and parameter display the measured results of the current sampling gas.

(6)When "standby mode" is selected, the multi-gas module will stop the measurement.

NOTE: After powering on or the first time switching from Standby to Measurement mode, zeroing is required. The channel will display Zeroing for 4 seconds, and then start
zeroing which lasts for 2 minutes. After zeroing is completed, it will automatically
enter into measurement mode.

14.5 Display

Anesthetic gas parameter display consists of:
Waveform: CO_2 , N_2O, anesthetic agents

Parameter: The inhaled & exhaled CO_2, N_2O, five anesthetic agents (one anesthetic agent at a time)

Gas Channel Window

Each gas has its own window, with the following items being displayed:

Waveform, reading of "in" and"et".

Gas Channel Parameter Window

The gas parameter window displays measured parameters of CO_2 , N_2O, and anesthetic agents.

NOTE: If you have any doubt as to the accuracy of the displayed value, check for leakage or occlusion in the water trap and exhaust tube.

NOTE: If the waveform seems to be abnormally flat, check the water trap and sampling line for any leakage or occlusion. Replace the water trap or sam

14.6 Precautions

The measurement range and accuracy of each gas are as follows:

O_2 : 5.0~100 Vol.% ± 3 Vol.%

CO_2 : 0~10.0 Vol.% ± 0.5 Vol. % or ±12% rel

N_2O : 0~100 Vol.% ± (2.00 Vol.%+8% rel)

Anesthetic Agents:

HAL:0~8.5 Vol.% ± (0.15 Vol.%+15% rel)
ISO: 0~8.5 Vol.% ± (0.15 Vol.%+15% rel)
ENF: 0~10.0 Vol.% ± (0.15 Vol.%+15% rel)
SEV: 0~10.0 Vol.% ± (0.15 Vol.%+15% rel)
DES: 0~20.0 Vol.% ± (0.15 Vol.%+15% rel)

During measurement, only the selected anesthetic agent is displayed.

NOTE: In order to assure the gas measurement accuracy, the module will automatically start calibration after continuous operation for more than 2 hours. The calibration takes about ten seconds. The channel will display "Zeroing", and the parameter box will display "--". After zeroing is completed, it will return to normal measurement status.

14.7 Alarm

The multi-gas module has alarms for values exceeding the preset limits, apnea, and for abnormal status.

NOTE: Alarm can be turned off in the menu.

Alarm for Parameters Exceeding Preset Limits
Alarm will be activated when the measured parameter exceeds the preset parameter alarm limits.

CO_2 alarm limit setup

Default ET：8, 50, IN：0, 8

Range：0~76mmHg

N_2O alarm limit setup

Default IN：50, 80

Range：0~100%

O_2 alarm limit setup

Default ET：30, 70，IN：20, 80，

Range：5~100%

Anesthetic agent alarm parameter setup：

HAL Default ET：1.0, 3.0，IN：1.0, 3.0

Range：0~8.5%

ISO Default ET：1.0, 3.0，IN：1.0, 3.0

Range：0~8.5%

ENF Default ET：1.0, 3.0，IN：1.0, 3.0

Range：0~10.0%

SEV Default ET：1.0, 3.0，IN：1.0, 3.0

Range：0~10.0%

DES Default ET：1.0, 3.0，IN：1.0, 3.0

Range：0~20.0%

Apnea Alarm

When apnea alarm is on, if no breath is detected for the preset period, the apnea alarm will be activated.

NOTE: The Multi-gas module and the patient monitor system have a smart apnea alarm function. That is, there will be no alarm during the period when the patient monitor is just powered on. It will only activate the apnea alarm after it has detected respiration and later it identifies there is an apnea.

NOTE: The apnea alarm is a high priority alarm. So when apnea alarm occurs, the red light flashes.

Abnormal Status

Abnormal status refers to sampling line occlusion or water trap error.

NOTE: When there is any occlusion, leakage or damage in the gas channel, the error message will be displayed within 1 to 2 minutes after the abnormal status occurs.

14.8 Cleaning and Maintenance

Multi-gas Module

NOTE: Prevent disinfectant or its fumes from entering into the gas module through the tubing. Otherwise the module performance may be degraded or damaged.

Accessories

Replacement Procedures:

Water trap: Empty before it is full using a syringe. Replace if contaminated or occluded.

Gas sampling line: Reusable

Standard gas tube connector: Disposable

Anesthetic gas exhaust tube: Reusable, only needs to be replaced when broken. Make sure the connection is tight when doing replacement.

Cleaning Procedures:

Water trap: Do not attempt to sterilize or clean it. Empty it before it fills and replace when contaminated or occluded.

Gas sampling line, and standard gas tube connector:

Before cleaning the sampling line and gas tube connector, please get the following ready:

Distilled water

Citric acid compound liquid

Container-big enough to immerse the tube

Injector

Steps:

1.Flush out any granule residue in the tube with distilled water

2.Then, wash the tube with citric acid compound liquid, immerse the tube in

citric acid for 20 minutes. Make sure that the tube is fully immersed.
3.Wash the tube with citric acid compound liquid again.
4.Flush out the citric acid residue with distilled water.
5.Inject air into the tube with the injector to remove the remaining water. Do not use compressed air.
6.Make sure the tube is completely dry before using it.

Anesthetic gas exhaust tube:
Cleaning: Wipe the tube with a piece of soft cloth damped in mild soap water, then wipe it with a piece of dry cloth. Do not immerse it in any liquid.

Disinfecting: Wipe the tube with a piece of soft cloth damped in cold chemical disinfectant. Do not immerse it in the liquid. After disinfecting, remove the disinfectant residue with a piece of cloth and keep it dry.

Solution for Occlusion

Entrance Occlusion:

When entrance accessories (water trap, sampling line, standard gas tube connector) are occluded or entangled,
1. Replace the water trap
2. Check the sampling line for occlusion, entanglement and replace it when necessary.
3. Check the gas channel connector to see if water is accumulated. If necessary, remove the liquid and change the connector position. Make sure the gas channel is connected correctly.

Exhaust System Occlusion:
When the exhaust accessories (sealing rings or exhaust gas tube) are occluded or entangled, please
1. Check the exhaust system accessories for occlusion or entanglement. If necessary, replace it.
2. Start Zeroing.

NOTE: When the gas inlet or outlet system accessories become occluded or entangled, first check the exhaust system accessories for occlusion. If necessary, replace them. If after exhaust accessories are replaced and occlusion still exists, please check the gas inlet accessories for occlusion and replace them if necessary.

SECTION 15 CLEANING AND MAINTENANCE

15.1 Cleaning

WARNING: Do not, under any circumstances, perform any testing or maintenance on the monitor while the monitor is being used to monitor a patient. The monitor must be turned "OFF". Unplug the monitor from the AC power source and remove the internal battery.

CAUTION: Do not open the monitor to clean or repair it. Contact Midmark for service needs.

CAUTION: Disconnect all accessories from the monitor before cleaning. Do not immerse any part of the electrical connector of the cable or accessories in the cleaning or disinfection solution at any time. Do not use an abrasive cloth or cleaner on the accessories.

Immersing the patient cable or lead wires in any liquid may result in moisture entering. This may cause internal damage and reduce the product life. Alcohol and organic solvents may cause stiffness and brittleness.

THE MONITOR

On a daily basis, examine the monitor's case for damage and check the AC power cord for bent or broken prongs, cracks or fraying. Neither the monitor nor the power cord should be used if damaged. If any damage is noted, contact the appropriate service personnel.

CAUTION: Do not spray or pour any water or cleaning solution directly onto the monitor.

As needed, clean the monitor using a soft cloth dampened with a mild dishwashing detergent solution and gently rub the soiled area until clean. Use a clean soft cloth to dry the monitor. Do not use abrasive cleaners on the monitor. Do not use either isopropyl alcohol or solvent to clean the monitor. Use of these cleaners can cause damage to the monitor's surface. Do not immerse the monitor or power cord in the cleaning solution.

When necessary, the monitor surfaces may be disinfected using a soft cloth saturated with a 10% (1:10) solution of chlorine bleach in tap water. When all of the surfaces have been disinfected, wipe the entire surface of the monitor using a soft cloth dampened with fresh water to remove any trace amounts of residue and/or fumes.

NOTE: Thoroughly wipe off any excess cleaning solutions. Care should be taken to prevent water or cleaning solution to run into connector openings or crevices.

THE DISPLAY

CAUTION: Use care when cleaning the display. Do not use a paper towel to clean the display as this may cause scratches.

Occasionally, as needed, clean the display window using a soft, lint-free cloth sprayed with an alcohol free glass cleaner. Do not use either isopropyl alcohol or solvent to clean the display. Use of these cleaners can cause damage to the display. The use of paper towels is not recommended as it may scratch the surface.

PATIENT CABLE AND LEADWIRES

Prior to each patient use, inspect the patient cable and leadwires for damage. As necessary, clean the patient cable and leadwires using a soft cloth dampened with a germicidal solution.

CUFFS

Prior to each patient use, inspect the blood pressure cuff and its hose for damage.

REUSABLE (NYLON) CUFFS

As necessary, for normal cleaning with mild detergents / dilute bleach solution (1-2%), wipe the cuff with the cleaning solution, rinse with water and dry.

NOTE: Midmark does not recommend submersion of the cuff. Liquid should not be permitted to enter the cuff bladder because instrument damage may occur. The cuff should be allowed to thoroughly dry before use.

DISPOSABLE (VINYL) CUFFS

In certain situations, the cuff may become soiled during its use. In these situations a water-based detergent is suitable for wiping the cuff.

As necessary, the preferred method for cleaning the cuff is to wipe it down with a damp, soapy cloth. A damp, detergent-free cloth should then be used to rinse the cuff.

NOTE: Midmark does not recommend submersion of the cuff. Liquid should not be permitted to enter the cuff bladder because instrument damage may occur. The cuff should be allowed to thoroughly dry before use.

PNEUMATIC TUBING

Prior to each patient use, inspect the NIBP Inflation Hose for proper connection, cracks and kinks. As necessary, clean the pneumatic tubing using a soft cloth dampened with a germicidal solution.

CO_2 CONSUMABLES

LoFlo and CStat5 CO_2 consumables are intended for single patient use in human medicine, but in the veterinary setting, may be reused as long as any moisture is allowed to dry between uses. It is estimated that with fairly regular use, the sampling lines should be replaced every 60 to 90 days.

Do not attempt to disinfect or flush the FilterLine as the monitor can be damaged. Refer to the manufacturer's instructions enclosed with each sensor for more information.

SpO_2 INTERCONNECT CABLE

Prior to each patient use, inspect the SpO_2 Interconnect cable for damage. As necessary clean the cable using a soft cloth dampened with a germicidal solution.

SENSOR AND CLIPS

CAUTION: To avoid damage to the VetSat sensor, remove it from the clip before cleaning either piece.

CAUTION: Do not sterilize the sensor or clips by irradiation, steam or ethylene oxide. Do not immerse the sensors in water or cleaning solution.

When necessary, the sensor may be surface-cleaned by wiping it with an agent such as 70% Isopropyl Alcohol.

The clip may be cleaned by either wiping it with, or soaking it for ten (10) minutes in, 70% Isopropyl Alcohol. If the clip is soaked, be sure to rinse it with water and air-dry it prior to use on the next patient.

After each cleaning and prior to each use, inspect the sensor and cable for fraying, cracking, breakage, or other damage. Inspect the clip for cracking or breakage, or loss of spring tension that would allow slippage or movement of the sensor from its proper position.

NOTE: If defects are noted, do not use the sensor or clip.

Refer to the Directions For Use pamphlet enclosed with the sensor for more information.

TEMPERATURE PROBES

As necessary, the probes should be cleaned with a mild detergent and water to remove excess bioburden. When necessary, the probes may be disinfected

using a soft cloth saturated with a 10% (1:10) solution of chlorine bleach in tap water or 70% isopropyl alcohol. When all of the surfaces have been disinfected, wipe the entire surface of the monitor using a soft cloth dampened with fresh water to remove any trace amounts of residue and/or fumes.

15.2 System Calibration

Besides the routine cleaning of the monitor and accessories outlined in the previous section, and replacement of accessories due to normal wear and tear, calibration of the monitor should not be necessary during the warranty period.

If the monitor is in need of repair, it must be referred to the appropriate service personnel. Service performed by unauthorized personnel could be detrimental to the monitor and may void the warranty. For service, contact Midmark.

Appendix 1 Product Specifications

I. Safety

Safety Class	Classl, with internal power supply
Device	Continuous working non AP/APG device

II. Power Supply Requirements

Input Power Supply Voltage: a.c. 100V ~ a.c. 242V ，50Hz/60Hz

Input Power: ≤150VA

Battery Capacity: 12V/4.6 Ah. Charging time≥8 hours

Battery backup working time: ≥1.5 hours per battery

Charging mode:	Automatically charged (with charge protection feature). While the device is powered by AC power mains.
Discharge Protection	When powered by battery, the device will be automatically powered off when the battery power is almost used up.

III. Performance Specifications

1. ECG

CMRR	≥60dB
Heart Rate Measurement and Alarm Range	15 ~ 300bpm
Accuracy	±1bpm
Heart Rate Average	8 beats

ECG Display Channel	8 channels
Pacemaker detection/rejection:	
Input voltage range:	±2mV to ±700mV
Input pulse width：	0.2ms to 2.0ms
Interface	AAMI 6-pin
Lead selection	I, II, III, V, avR, avL, avF (5-lead mode)
Lead fault alarm	Audible and visual indication
Input	3 or 5-lead ECG cable
QRS indicator	Audible and visual (heart mark flashes)
Waveform memory	12 minutes
Sweep speed	12.5 /25 /50 mm/s
Amplitude selection	X1/4, X1/2, X1, X2, X4, Auto
Trend	2 hours → 4 hours → 8 hours → 24 hours → 48 hours s → 72 hours → 96 hours →120 hours
Frequency response	Monitoring: 0.5~35 Hz Diagnosis: 0.05~100 Hz
Heart rate alarm duration	Less than 7 seconds
Defibrillation protection	Tested with 5kV
Recovery after defibrillation	Less than 5 seconds

2. RESPIRATION

Measurement method:	Thoracic impedance or direct with CO_2
Respiration rate measurement and alarm range:	0 ~ 150 brpm±2brpm
Waveform speed:	6.25、12.5、25mm/s
Respiration asphyxy alarm	0 ~ 120s

Respiration lead selection	RA-LA，RA-LL，RL-LL，RL-LA

3. IBP（Optional）

Measurement and alarm range	-30~300 mmHg
Scale	mmHg/kPa
Channel	single channels or double channels
Resolution	1 mmHg
Trend storage time	120 hours
Waveform speed	12.5, 25,50mm/s±10%
Transducer sensitivity	5uV/V/mmHg
Transducer type	Disposable
Update time	Approx. 1 second

4. SpO_2

SpO_2 Measurement and Alarm range	0 ~ 100%
SpO_2 Average	8 beats
SpO_2 Accuracy	±2%（70 ~100%），±3%（50 ~ 69%）
SpO_2 Pulse rate	30 ~ 250bpm
SpO_2 Pulse rate average	8 seconds
SpO_2 Pulse rate accuracy	±2bpm
Update time	Approx. 1 seconds
Pulse rate alarm limits	0 ~ 240bpm
Pulse sound	Pulse sound indication
Sensor type	Finger tip, universal Y, wrap
Internal LED waveform	Infrared: 940nm Red light: 660nm

Light power dissipation	Infrared light ≤22.5 mW
	Red light ≤30 mW
Pulse rate indication	Digital

5. NIBP

Method	Auto oscilloscope
Parameters	SYS, DIA, MAP, Pulse rate
Scale	mmHg /kPa
Operation mode	Manual, Auto, Stat
Repeat cycle	1~10, 15, 30, 60, 90, 120 , 240 , 480 minutes
Measurement and alarm range	
Systolic	20-265mmHg
Diastolic	15-220mmHg
Pulse rate range	0-300 bpm
Measurement time	Typical measurement time is 20 seconds STAT: Typical measurement time is 20 seconds
Pressure display accuracy	±5mmHg
NIBP pulse rate accuracy	±2% or 2bpm, whichever is greater

6. TEMPERATURE (2-channel)

Measurement and Alarm range	0 ~ 50℃
Probe	Rectal/Esophageal
Unit	Celsius /Fahrenheit
Accuracy	±0.1 ℃

Resolution	0.1℃
Update time	Approx. 1 second

7. CO_2（$EtCO_2$ & $InCO_2$) (Optional)

Working mode	Measurement/standby
Measurement range	0 ~ 99 mmHg
Scale	mmHg / kPa
Accuracy	±2 mmHg （0 ~ 39 mmHg）
	±5%（40~ 99 mmHg）
	±0.08 % for every 1mmHg above 38
Resolution	1 mmHg
CO_2 Respiration	0 ~ 150 brpm±2brpm
Waveform speed	6.25, 12.5, 25mm/s

8. Multi-gas (Optional)

Measure range and accuracy:

O_2：	5.0~100 Vol.%	± 3 Vol.%
CO_2：	0~10.0 Vol.%	± 0.5 Vol. % or ±12% rel
N_2O：	0~100 Vol.%	+ （2.00 Vol.%+8% rel）
HAL：	0~8.5 Vol.%	±（0.15 Vol.%+15% rel）
ISO：	0~8.5 Vol.%	±（0.15 Vol.%+15% rel）
ENF：	0~10.0 Vol.%	±（0.15 Vol.%+15% rel）

SEV：	0~10.0 Vol.%	± （0.15 Vol.%+15% rel）
DES：	0~20.0 Vol.%	± （0.15 Vol.%+15% rel）

Unit: mmHg/kPa

IV. Display

Display	Color TFT LCD
Size	12.1"
Display Channel	6 or 8

V. Recorder

Type	Thermal recorder
Printing mode	Real-time & alarm triggered printing of waveform and text
Printing channel	2/3 channels
Printing speed	Auto/12.5/25.0mm/s

VI. Physical Specifications

Net Weight	15.8 lbs. / 6.5 kg
Gross Weight	19.8 lbs. / 9.0 kg
Dimensions	450×380×390 mm^3

VII. Environmental Specifications

Temperature

Working	0 ~ 40℃
Storage and Transportation	-20 ~ +55°C

Relative Humidity

Working	≤80% （non condensing）
Storage and Transportation	≤95% （non condensing）

Barometric pressure

Working	86 ~ 106 kPa
Storage and Transportation	50 ~ 106 kPa

Specifications subject to change without prior notice.

APPENDIX 2 BP REFERENCE VALUES

Which Blood Pressure is Normal in Dogs or Cats?[1]

It is essential to know the reference range of blood pressure in a given species in order to properly evaluate the animal's blood pressure and detect hypertension or hypotension. When using different measurement techniques (oscillometry or direct blood pressure measurements), one must also remember that methodological factors influence results. Therefore, technique-specific reference values should be known. Species-specific, breed-specific, and individual differences in normal blood pressure ranges can be observed. The most accurate assessments are made by comparing different blood pressure readings over time using serial measurements made at regular intervals (at least once yearly). This makes it possible to detect the initial signs of related disease (e.g. cardiovascular and renal disease) more sensitively and at an earlier stage. The normal values for dogs and cats are not identical.

FELINE NORMAL VALUES

The blood pressure values for cats are not breed-specific. However, the most sensitive way to detect changes in feline blood pressure is also by comparing individual blood pressure readings taken over time.

Normal feline blood pressure: **124/84**

Other investigators have reported comparable reference values:

Feline Reference Values		
Systolic (mmHg)	Diastolic (mmHg)	
125 ± 11	89 ± 9	Brown et al, 1997
123 ± 14	88 ± 15	Curtet, 2001
125 ± 12	86 ± 15	Weber et al, 2002

CANINE NORMAL VALUES

The normal values for dogs are breed-specific. Those for Golden Retrievers, Labradors

1 Adapted from "Essential Facts of Blood Pressure in Dogs and Cats," Egner, Carr & Brown, © 2003

and giant breeds tend to be lower than the overall average, and those for greyhounds and in general racing hounds tend to be higher. The table that follows lists the normal values for common dog breeds using oscillometric blood pressure monitors.

Average canine blood pressure: 133/75

This figure was calculated as the mean of 1782 oscillometric measurement in clinically healthy dogs of different breeds. The overall average is therefore serves as a point of reference only. The individual, or at least breed-specific value must be known to most accurately determine whether a given patient's blood pressure deviates from normal.

Breed	Systolic (mmHg)	Diastolic (mmHg)	Pulse Rate
Labrador Retriever	118 ± 17	66 ± 13	99 ± 19
Golden Retriever	122 ± 14	70 ± 11	95 ± 15
Great Pyrenees	120 ± 16	66 ± 6	95 ± 15
Yorkshire Terrier	121 ± 12	69 ± 13	120 ± 14
West Highland	126 ± 6	83 ± 7	112 ± 13
Border Collie	131 ± 14	75 ± 12	101 ± 21
King Charles Spaniel	131 ± 16	72 ± 14	124 ± 24
German Shepherd	132 ± 13	75 ± 10	108 ± 23
Terrier	136 ± 16	76 ± 12	104 ± 16
Bullterrier	134 ± 12	77 ± 17	122 ± 6
Chihuahua	134 ± 9	84 ± 12	109 ± 12
Miniature Breeds	136 ± 13	74 ± 17	117 ± 13
Pomeranian	136 ± 12	76 ± 13	131 ± 14
Beagle	140 ± 15	79 ± 13	104 ± 16
Dachshound	142 ± 10	85 ± 15	98 ± 17
Saluki	143 ± 16	88 ± 10	98 ± 22
Greyhound	149 ± 20	87 ± 16	114 ± 28
Pointer	145 ± 17	83 ± 15	102 ± 14

GUIDELINES[2]

Mean Arterial Pressure (MAP): Minimum to adequately perfuse all peripheral tissue beds: 60-70 mmHg.

Hypertension: Suspect with systolic pressure greater than 150 mmHg; affirmed when

2 Info per Dr. Donald Sawyer, Michigan State University

above 160 170 mmHg; also affirmed in cats when diastolic pressure is above 100 mmHg.
Hypotension: During anesthesia, generally maintain systolic pressure above 80 mmHg.

APPENDIX 3 DEAD SPACE-Cause, Effect, & Control in Small Animal Anesthesia

Robert M. Stein, D.V.M.. DAAPM
Founder **www.VASG.org**

Dead space is an often misunderstood and overlooked aspect of veterinary anesthesia patient management. Dead space is always present as a component of the patient's airway and, to a variable degree, as a component of the anesthetic system. Ignoring the harmful consequences of system dead space can lead to potentially fatal patient outcomes. This is especially worrisome when managing small patients.

There are three different types of dead space: anatomic, alveolar, and mechanical (equipment). Dead space ventilation involves that component of the respiratory gases that does not participate in gas exchange. Simply said, there is no patient benefit from dead space ventilation. If mechanical dead space volume equals or exceeds alveolar ventilation volume the patient will not be able to clear carbon dioxide at all. Ideally, your goal should be to minimize dead space through proper patient planning and to detect excess dead space consequences through end-tidal CO2 monitoring.

Anatomic dead space is comprised of the upper airway structures that do not participate in gas exchange. This includes the gases in the nasal passages, nasopharynx, larynx, trachea, and in the larger airways. **Alveolar dead space** represents those alveoli that are ventilated with fresh gas but not perfused by the pulmonary circulation. **Mechanical or equipment dead space** is made up of any portion of the endotracheal tube extending beyond the patient's incisors, patient monitor adaptors (ETCO2, apnea alert, etc.), any adaptors used to facilitate patient/system positioning (right-angle or swivel adaptors used to reduce the risk of tracheal trauma during patient rotation), the pace within a mask not occupied by the patient's nose, humidification management exchangers (HME), and the "Y" piece (defined as the terminal end of an F circuit or noncircle system and the inhalation/exhalation hose connector in a circle system).

Exhausted soda lime or malfunctioning one-way valves can also contribute to increasing mechanical dead space. Dead space also increases in a non-rebreathing system when fresh gas flows are inadequate or when certain defects are present in the system (for instance, when the center tube of a Bain system or F circuit is cracked or broken). These dead space contributors can all be controlled through proper system inspection and

maintenance.

Mechanical dead space gas is the first gas inhaled at the beginning of the each respiratory cycle. As the mechanical dead space volume increases, ***less*** fresh gas moves into the patient's alveoli, limiting gas exchange.

Anesthetic System							
	Norman Elbow	Jackson-Rees	Bain	Ped circle	Adult circle	Adult F	Ped F
Dead space	<1 ml	3 ml	4 ml	4 ml	8 ml	8 ml	15 ml

Adaptors					
	ET tube	Monitor - ped	Monitor - adult	Positional	Heat & Moisture Exchanger (HME)
Dead Space	2 ml	2 ml	7 ml	8 ml	2.5 to 90 ml

The consequences of excessive mechanical dead space can be substantial and, potentially, fatal. As dead space volume from any cause increases, effective alveolar ventilation decreases. In patients breathing 100% oxygen there may be negligible initial effect on arterial oxygen tension. Arterial CO_2, however, can reach impressive levels. It is possible to have an end-tidal CO_2 level greater than 110 mmHg in patients with a normal pulse oximeter reading.

- Increased arterial CO_2 causes:
    - Respiratory acidosis
    - Sympathetic stimulation
    - Cardiac arrhythmias
        - A mix of sympathetic stimulation and hypoxemic effects
    - Variable peripheral vasoconstriction (sympathetic effect) followed by peripheral vasodilation as a direct effect on peripheral vessels
    - CNS depressant effect and, eventually narcosis
        - $PaCO_2$ levels above 100 mmHg have an anesthetic effect
    - Increased cerebral blood flow and intracranial pressure
    - Tachypnea and an increased work of breathing which can negatively impact a debilitated patient
- Arterial O_2 levels may eventually decrease enough to cause hypoxemia, especially in a patient breathing room air
- Inadequate ventilation interferes with adjustments in anesthetic levels

Controlling mechanical dead space is a simple matter.

- Mechanical dead space is most concerning for patients under 6 kg body weight
    - Minimize the connectors attached to the endotracheal tube, particularly in small patients.
        - For example, in a 6 kg patient under anesthesia the patient's alveolar ventilation volume would be 31.5 ml. Using a pediatric F circuit with adult $EtCO_2$ monitor and right angle adaptor (or apnea alert adaptor) could create 30 ml of mechanical dead space; effectively eliminating 95% of normal spontaneous alveolar ventilation.
- Make sure you regularly inspect all anesthetic machines and systems paying particular attention to valve function and inner hose integrity
- Make sure that the ET tube is not excessively long
- Select your anesthetic system carefully
    - Do **not** use a pediatric F circuit as a substitute for conventional pediatric circle hoses or a noncircle system
- Using no more than one monitor adaptor
    - Make sure it is a pediatric, low volume adaptor for smaller patients to avoid any significant impact on total mechanical dead space
- Avoid the use of positional (right angle) adaptors in smaller patients
- Avoid maintaining anesthesia with a facemask

Simply put, anesthetized patients should have their end-tidal CO_2 monitored for maximal patient safety.

APPENDIX 4 DIRECT BP MONITORING

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Blood pressure is considered an important component of patient monitoring in emergency and critical care medicine. Blood pressure is a product of several cardiovascular parameters including cardiac output (stroke volume x heart rate), volumetric compliance of peripheral blood vessels (systemic vascular resistance) and effective circulating blood volume. Veterinary medicine has embraced blood pressure measurement as an important monitoring tool for a variety of medical and surgical situations. In most cases, current clinical practice measures blood pressure by an *indirect technique* which relies on surface pressure occlusion of a superficial artery using a pneumatic cuff and a method to detect blood flow distal to the site of cuff occlusion. Accepted detection methods to identify blood flow include auscultation, oscillometry, palpation, ultrasonic, and photoelectric methods. Although valuable, it has long been recognized that all indirect methods have limitations in accurate measurement associated with both patient and operator factors. Also, indirect blood pressure measurement is not robust, meaning that it cannot be accurately measured during low pressure and vasoconstricted states.

Because there are limits to indirect blood pressure measurement, there is increased interest in direct blood pressure monitoring in patients demonstrating abnormal physiology that may render indirect measurement techniques inaccurate or impossible. Direct blood pressure measurement requires introduction of a catheter into an arterial or venous lumen and equipment and supplies to transfer pressure from the catheter tip to a measurement device. For this reason, direct measurement is technically more demanding than indirect techniques but less prone to measurement error. The purpose of this presentation is to review the theory, practice, and techniques for direct arterial blood pressure measurement in dogs and cats.

Equipment needed for direct blood pressure measurement

Equipment and supplies: Essential equipment and supplies needed for direct blood pressure monitoring include arterial catheters (see below), side port catheter adapter, low compliance extension tubing, three way stopcocks,

pressure measurement device (transducer), pressure analysis and display device (ECG/BP monitor), heparinized saline, and syringes/needles.
For long term placement, a constant flush device (Intraflow®), IV tubing, 1L normal saline, heparin, and pressure infuser device permits continuous flush infusion to prevent clot formation. General supplies such as elasticized and regular tape, suture, scrub solution, and assorted needles should be available. Local anesthesia (2% lidocaine HCl) may be injected in the vicinity of the artery to reduce vasospasm during the procedure.

Catheter selection: Either short or long catheters may be successfully used for direct blood pressure measurement. The preferred biomaterials for arterial catheters are either PFE (Teflon®) or polyurethane. In most cases, short length catheters (2-3")are used in patients who require short term blood pressure monitoring (i.e. anesthesia, short term procedures) or are relatively immobile. Long length indwelling catheters (4+") are preferred for long term monitoring or in mobile patients. The gauge of catheter is based on vessel diameter at the placement site. In dogs, 20-24 G x 2-3" over the needle catheters are used in the dorsal pedal, metatarsal, and popliteal arteries. In cats, a 22-24G x 2" catheter is selected for the same arterial sites. Large diameter arterial segments (femoral and brachial a.) may accommodate a 20 G x 2-3" over the needle catheter in the dog and a 22 G x 2-3" catheter in the cat. Several manufacturers (Arrow,
BD) offer an over the needle catheter system with a built in guide wire that is intended to facilitate arterial catheter placement. In these systems, the guide wire is first advanced and the catheter is then placed over the guide wire. This system is helpful when challenging cases are encountered. Long catheters are generally selected in large bore (femoral and brachial a.) arteries where stabilization is challenging. The additional length of the catheter allows the catheter tip to be located in a more central arterial location and adds additional length that reduces accidental catheter dislodgment.

Technique for setting up direct blood pressure monitoring
Equipment set up and preparation: Prior to beginning the procedure, all equipment and supplies should be assembled and be ready to use. The first step is to attach the pressure transducer to the patient monitor at the appropriate plug site. Following attachment, connect three way stopcocks to the luer adapters in the transducer housing. In permanent transducers, two stopcocks

are required, in disposable units, only one may be necessary.

Leave one stopcock "open" to room air and fill the chamber with heparinized saline being sure that ALL air bubbles are removed. After filling, leave the stopcock open and "zero" the transducer to the machine by pressing the zero control button on the monitor panel. This adjusts the electronics to provide accurate measurement. This step will be repeated after patient attachment occurs. After filling and zeroing the transducer, a flush infusion device is attached to one stopcock unless it is embedded in the transducer device. An IV bag with heparinzed saline is placed in a pressure sleeve and an IV infusion set (microdrip) is attached to the flush device and the bag pressurized to 300 mm Hg. A 6-12" length of low compliance IV tubing is attached to a stopcock to interface the catheter to the transducer. This tubing is flushed and filled with heparinzed saline. The stopcock is turned off to prevent fluid drainage once the tubing is filled. A catheter adapter with a side port is flushed with heparinized saline filled syringe with the syringe attached after flushing. The catheter, catheter supplies, and prep solution are assembled and organized on a work surface for easy access.

Catheter placement sites: A superficial artery amenable to catheter placement is identified. Reported sites for arterial catheter placement in dogs and cats include the dorsal pedal, metatarsal, popliteal and femoral arteries in the hind limb and the brachial artery in the forelimb. In general, distal rear limb sites are selected based on ease of identification, catheter placement, and stabilization following catheter insertion. The selected site must be clipped and surgically prepped prior to catheter placement. Failure to aseptically prepare the area can lead to systemic infection.

Catheterization technique: The artery is palpated for pulse quality. In hypotensive patients, peripheral arterial sites may not be detectable due to low blood flow and poor pulse quality. Following identification, a small amount of 2% lidocaine is infiltrated in proximity to the vessel to reduce vasospasm and desensitize the area for catheter placement. Do not remove the filter cap from the needle hub prior to placement. You will be entering a high pressure vessel and will have a sudden burst of blood back through the catheter hub if it is uncovered. The catheter is initially introduced through the skin. In some cases, a pilot wound is created if skin is tough and may damage initial catheter

insertion. Once the catheter is inserted through the skin, it is SLOWLY advanced while a finger is kept over the artery to "feel" when the catheter intersects the vessel. You can feel the vessel wall because it is a muscular structure and may actually feel a pulsation as the needle tip engages the arterial wall. At this point, a "flash" may be noted in the needle hub. Once the "flash" is noted, stabilize the catheter unit. If you are using a guide wire catheter, slowly advance the wire stylette. It should move easily or only encounter slight resistance if you are in the vessel lumen. Once the guide wire is inserted full length, slowly advance the catheter until the catheter hub is at the skin surface. If using a standard catheter, slowly advance the catheter. There should be slight resistance due to tissue "drag" but the catheter should go smoothly. After catheter placement is confirmed, gently compress over the vessel at the catheter tip, remove the stylette and needle, and cap the catheter hub with the adapter. An initial aspiration should easily produce a blood "flash" into the saline solution. Flush in 2-3 cc of heparinized saline solution to clear blood from the catheter lumen. Secure the catheter in place prior to proceeding further.

Connection to BP monitor: Flush the connecting tubing with saline using the flush device embedded in the disposable transducer or by using a saline filled syringe attached to the stopcock immediately adjacent to the extension tubing. Be sure that there are no visible air bubbles following the flush procedure. Attach the connecting tubing to the catheter adapter extension. You should see a pressure waveform on the monitor screen after opening the stopcocks to the system. Level the transducer at the estimated base of the heart (point of the shoulder). Close the line to the patient and open it up to room air using the stopcock. Press the zero button again to recalibrate the system to the patient. Close the stopcock to air and open the line to the patient. You are now measuring direct blood pressure.

Blood pressure waveform

Arterial waveforms emanate from the pulse pressure created by ventricular systole and diastole. The arterial pulse pressure wave begins as left ventricular contraction and forward blood flow (stroke volume) creates aortic distention within the closed vascular system. Peak aortic blood flow produces the initial upstroke in the pressure pulse while continuous ejection of blood from the ventricle during systole fills out or sustains the pulse waveform. As pressure

and flow reach their maximum values, the curve flattens and reaches peak pressure. The rounded, sustained portion of the pressure wave represents a combined effect of ventricular volume ejection, distention of the entire aorta, and runoff into aortic branches. Following this point, the curve begins to descend until a defined upstroke or "notch" on the downside of the pressure curve is noted. This notch, referred to as the dicrotic notch, represents closure of the aortic valve and secondary pressure generation that occurs by distention and compression of the aortic root following valve closure. As pressure falls further during "run off" of blood into the arterial ranches, the pressure curve descends to its lowest pressure point just prior to the next cardiac cycle.

The arterial waveform varies with the site of catheter placement and its distance from the aortic root. The further the distance from the heart, the more "tented" or "peaked" the waveform appears. This is accompanied by a narrower base or distance from the beginning to end of the waveform. This appearance change is due to several factors including pressure drop and diameter of blood vessel. The important point is that the waveform change reflects a lower mean arterial pressure, which is essential for forward blood flow to all tissues and organs.

When concurrently monitoring electrocardiogram (ECG) and arterial blood pressure, one notes a slight "delay" between the ECG signal and blood pressure waveform during a cardiac cycle. This delay represents the time required to produce electromechanical coupling and isometric ventricular contraction prior to forward blood flow and pressure wave generation.

Factors affecting measurement

Direct blood pressure measurement is affected by both patient and technical factors. Physiologic status of the patient including circulating blood volume, cardiac contractility, neuroendocrine status, and peripheral vascular state all contribute to blood pressure values. Support measures such as mechanical ventilation or other procedures which impact on cardiovascular physiology also contribute to accurate measurement. The reader is referred to reference material for further discussion of these issues. Technical issues also affect accurate measurement. Technical issues generally fall into three categories, catheter management, appropriate set up and management of the measurement apparatus, and operator error. Arterial catheter management is a critical issue in success. Placement should be on a "flat" surface away from joints or other

structures which may intermittently occlude the catheter lumen due to position or movement.
Continuous flushing of the catheter to avoid intraluminal clots is essential for long term patency and accuracy of measurement.

Ensuring an uninterrupted fluid interface between the catheter and transducer device is essential. Air bubbles in the transducer or extension tubing may "dampen" the signal producing errors. Correct procedural set up with "zeroing" the system is critical to ensure accurate values are measured. Attention to detail of the catheter and operating system by personnel is important to avoid errors and complications. Any break in the protocol may contribute to inaccurate measurement and increased patient risk.

Complications
Reported hazards of invasive arterial pressure monitoring include vascular injury, disconnection, accidental injection of drugs, infection, and damage to nearby nerves. In the author's experience, accidental disconnection and infection are two most common complications. Accidental disconnection can produce rapid exsanguination with the risk of hypotension, shock and death is possible if not immediately identified. Constant monitoring of the extension tubing and connection points is important to avoid this complication. Nosocomial infection may lead to bacteremia and sepsis. Sources of infection include catheter wound site, contamination of tubing and stopcocks during routine maintenance procedures, and reuse of non-sterile transducers. Attention to standard protocols targeted to reduce introduction of pathogens at tubing connection sites or ports is also important to decrease risk in these patients. In recent years, "closed" tubing systems which isolate operator maintenance functions from the primary system have become popular in human medicine.

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APPENDIX 5 ACCESSORIES

The following items are included in the standard monitor kit and can be reordered from your distributor or directly from Midmark using the associated reorder codes.

Reorder #	Description	incl
SV-1	2.0 cm bp cuff, for limb circumference 3-6cm (white vinyl fabric)	1
SV-2	2.5 cm bp cuff, for limb circumference 4-8cm (white vinyl fabric)	2
SV-3	3.5 cm bp cuff, for limb circumference 6-11cm (white vinyl fabric)	3
SV-4	4.0 cm bp cuff, for limb circumference 7-13cm (white vinyl fabric)	3
SV-5	5.0 cm bp cuff, for limb circumference 8-15cm (white vinyl fabric)	2
SV-8	8.0 cm bp cuff, for limb circumference 13-20cm (white vinyl fabric)	1
SV-10	10.2cm bp cuff, for limb circumference 18-26cm (white vinyl fabric)	1
01-03-0162	6' bp inflation hose with Quick Disconnect	1
016-1602-00	ECG Trunk Cable	1
016-1603-00	5-lead ECG wire set	1
ECG-A3	MAX-12/9500 ECG copper clips	5
V-SAT	6' Nellcor SpO2 lingual sensor and clips (large and small)	1
01-02-0183	10' Nellcor SpO2 extension cable	1
590004	MAX-1/MAX-12/9500 Flexible Esophageal/Rectal Temp probe	1
Paper4F	HD Printer paper (4 rolls/tube)	1
01-02-0395	MAX-12/9500 Power cord (USA)	1
Battery7C	MAX-12/9500 rechargeable sealed lead acid battery	2

The accessories associated with the optional invasive blood pressure monitoring configuration (MAX-12 DUO HDi and MAX-12 Hdim) are as follows:

Reorder #	Description	incl
650-208	Invasive Blood Pressure ("IBP") Interface cable	1
016-1587-00	IPB Transducer kit	1

The following are optional accessories for use with the MAX-12HD series:

Reorder #	**Description**
C-Stat 5	Capnostat Mainstream CO_2 probe (incl. airway adapters 6063 & 6312)
6063-00	CO_2 Small animal airway adapter (<5cc dead space)
6312-00	CO_2 Exotic animal airway adapter (<1cc dead space)
LoFlo	LoFlo Sidestream CO_2 module (incl. sampling lines 3473INF & 3473ADU)
3473INF-00	LoFlo airway adapter w/filter – small/neonate
3473ADU-00	LoFlo airway adapter w/filter – adult/pediatric
SV600	Package of 5 Cardell small animal cuffs (1 of each size)
MaxFast-1	Nellcor MaxFast Reflectance sensor & posey wrap
8008-001	MAX-12HD Rolling Stand w/basket and mounting plate
8008-003	MAX-12HD mount for the Canis Major lift table
9A465001	Mounting bracket for Matrx VMS Plus anesthesia machine
EP-S	MAX-12/9500 series small esophageal probe (ecg, temp, resp.)
EP-L	MAX-12/9500 series large esophageal probe (ecg, temp, resp.)
EP-XS	MAX-12/9500 series extra small esophageal probe (ecg, temp, resp.)
CD-0019	FLAT ECG CLIPS (PKG OF 5)